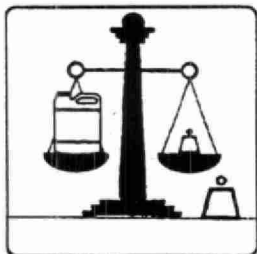


CA200
EU 356
1994
P28
C-2



Pesticide Vendor Certification Course



Manual



Copyright Provisions and Restrictions on Copying:

This Ontario Ministry of the Environment work is protected by Crown copyright (unless otherwise indicated), which is held by the Queen's Printer for Ontario. It may be reproduced for non-commercial purposes if credit is given and Crown copyright is acknowledged.

It may not be reproduced, in all or in part, for any commercial purpose except under a licence from the Queen's Printer for Ontario.

For information on reproducing Government of Ontario works, please contact ServiceOntario Publications at copyright@ontario.ca

Ontario Pesticide Education Program is grateful for the technical advice and support received from:

Ontario Ministry of Environment and Energy

Ontario Ministry of Agriculture, Food and Rural Affairs

AGCare

Agricultural Groups Concerned about Resources and the Environment
(representing 45,000 Ontario farmers)

C.P.I. Crop Protection Institute, Ontario Chapter
(representing pesticide manufacturers and distributors)

Pesticide Education Network

Ontario Pesticide Education Program also wishes to thank the British Columbia Ministry of the Environment and the Co-operative Extension Department of Cornell University.

Copyright ©1994, Ridgetown College of Agricultural Technology. All rights reserved. No part of this publication may be reproduced or transmitted in any form or by any means, without prior written consent of the Publisher.

The use of any product is not endorsed, recommended or criticized by its being mentioned in the Pesticide Vendor Certification Course (PVCC) material.

(This manual is based on the 1991 clear written edition of the Pesticide Vendor Certification Course manual.)

1990-91 Clear Writing and Design Project

Managed by Centralia College of Agricultural Technology

Sponsored by a Workplace Literacy Incentive Grant, Ontario Ministry of Education

Available through any office of the Ontario Ministry of Agriculture, Food and Rural Affairs

This book is also available from the Ontario Pesticide Education Program
Ridgetown, Ontario, N0P 2C0
(519)674-1580

ISBN 0-7778-3659-9

Table of Contents

Regulations

How Pesticides are Regulated	1
Enforcement of the Pesticides Act	9
Classification of Pesticides	13
Selling Pesticides	17

Product Information

The Pesticide Label	31
Pesticide Formulations	45
The Material Safety Data Sheet (MSDS)	53

Human Health

Risk of Pesticide Use	61
Pesticide Poisonings	67
First Aid	79

Pesticide Safety

Protective Clothing and Equipment	87
Transportation of Pesticides	99
How to Dispose of Pesticides Safely	107
How to Store Pesticides Safely	117

Pesticides and the Environment	129
--------------------------------------	-----

Food Safety	143
-------------------	-----

Pest Management

Choosing the Right Pest Control	147
Weeds and Their Control	157
Insects and Their Control	167
Diseases and Their Control	173
Animal Pests and Their Control	179
Selecting and Purchasing Advice to Customers	183

Applying Pesticides	
Application Equipment	187
Calibration of Application Equipment	221
How Well Pesticides Work	235
Applying the Right Amount of Pesticide	241
Keeping Pesticide Records	259
Emergency Response	
Health and Safety on the Job	265
Pesticide Spills	269
Pesticide Fires	279
Emergency Planning	285
Be A Professional	291

Appendices

Glossary of Terms	297
Answers to Review Questions	313
Information Numbers	329
MOEE Pesticides Control Field Offices	331
Safety Supply Companies	333
The Metric System	337
References	341
Notes	345

How Pesticides are Regulated

Federal Laws



The Pest Control Products Act (PCP Act) is the federal law that regulates all products used to control pests in Canada. The PCP Act was first passed in 1939 and new Regulations were added in 1972. The law was revised again in 1982.

The Pest Control Products Act

Before a pesticide can be sold or used in Canada, it must be registered under the PCP Act.

How a Product is Registered

Agriculture and Agri-Food Canada is responsible for administering the PCP Act and its Regulations.

Before a pesticide is registered, the manufacturer must prove that it is safe and effective when used as directed on the label. The manufacturer must submit scientific data on the chemistry, toxicology, metabolism, residues, environmental impact and effectiveness of the product. Agriculture and Agri-Food Canada works with experts from Health Canada, Environment Canada and Natural Resources Canada to review the information presented. They must be sure that the product will not be harmful to plants, animals or the public health.

Health Canada (Environmental Health Directorate), is responsible for assessing how dangerous pesticides are for the people who are exposed to them. They determine what precautionary statements and hazard symbols must appear on the label.

Re-evaluation of Registered Pesticides

The federal legislation on pesticides allows Agriculture and Agri-Food Canada to re-evaluate a registered product at any time if new information becomes available or if the manufacturer asks for a new use to be added to the label.

Within the past ten years, we have learned a lot more about the effectiveness of pesticides and their safety for the user and the environment. Agriculture and Agri-Food Canada reviews registered products according to the current information. They may decide that the product should be used in a different way or that additional precautions must be included on the label. They may even suspend or cancel a product.

When a product is **suspended**, any packages already at retail outlets may be sold, but the registrant may not distribute any more of the product.

When a product is **cancelled**, the product may not be sold even if it is already at retail outlets. In some cases, the product may even be recalled.

The company that registered the product (the registrant) may appeal any decision or change in the registration of their product. In some cases, the registrant may choose to remove the product voluntarily.

Other Federal Acts

Food & Drugs Act (FDA)

Other federal laws also regulate pesticides:

The Food and Drugs Act is administered by the Food Directorate of Health Canada. This Act protects the health of consumers by preventing the sale of food that contains any harmful or poisonous substance.

The Food Directorate determines the maximum amount of pesticide residue that may safely be contained in our foods. This amount is called the **maximum residue limit (MRL)**. The **MRL** is measured in parts per million and is based on the toxicity of the pesticide, its application rate and timing, and the crop to which it is being applied.

The Food Directorate sets limits on the time when pesticides may be applied to the crop. For example, they are responsible for statements on the label such as, "Do not apply within 10 days of harvest".

The Food Directorate also sets restrictions for feeding crop refuse to livestock. Any restrictions must appear on the label.

It is the responsibility of the primary producer (the farmer), the spray operator, and the food processor to make sure that all the restrictions are followed. If you ignore the restrictions you are breaking the law. Your crops or produce may be seized and you may face a fine or jail sentence.

Fertilizer Act

The Fertilizer Act is the federal law that regulates all fertilizers used in Canada, including fertilizers containing pesticides. Before a fertilizer/pesticide can be sold or used in Canada, it must be registered under the Fertilizer Act.

Pesticide Residues Compensation Act

This Act pays the producer for damages or losses if the sale of his produce is stopped because it contains more pesticide residue than the Food and Drugs Act allows.

The producer must prove that the pesticide was applied according to the label directions in order to be considered for compensation.

Feeds Act

The Feeds Act provides regulations to prevent the contamination of feed.

Fisheries Act

The Fisheries Act prevents anyone from placing harmful substances in water frequented by fish.

Migratory Birds Convention Act

The Migratory Birds Convention Act prevents anyone from placing harmful substances in water, or any area, frequented by waterfowl and migratory birds.

Transportation of Dangerous Goods Act

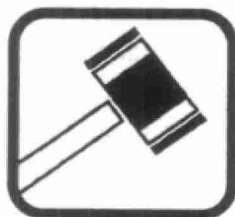
This Act is administered by Transport Canada. It controls the handling, offering for transport, and transport of hazardous products including some pesticides.

Canadian Environmental Protection Act (CEPA)

This Act protects the environment as well as human life and health. The Act covers many different areas including:

- procedures to review and approve chemicals
- mandatory reporting
- export and import controls
- recalls and clean-ups
- new inspection and enforcement powers.

Provincial Laws



In Ontario, pesticides, and fertilizers containing pesticides, are regulated by the **Pesticides Act and Regulation**. They are administered by the Ministry of Environment and Energy.

All pesticides registered under the federal PCP Act must be classified in Ontario before they can be offered for sale in Ontario.

Pesticides Act

Products are classified into one of six schedules (or categories) depending on:

- how poisonous they are (toxicity)
- whether they create environmental or health hazards
- how long they last in the environment (persistence)
- their concentration
- how they are used.

The Ontario Pesticides Advisory Committee (OPAC) reviews the technical information on each pesticide and recommends a classification to the Minister of Environment and Energy for approval.

The classification system allows Ontario to make sure that pesticides are only used by people who need them and have the knowledge to use them properly.

Ontario's Pesticide Schedules

Schedule	Used By
1	Licensed Applicator or Certified Farmer with approved permit
2,5	Licensed Applicator or Certified Farmer - no permit required
3,4,6	Licensed Applicator or Certified Farmer or Farmer (not certified) or Homeowner - no permit required

You can find the schedules of pesticides and fertilizers containing pesticides in the book "Pesticide Products Classified in Ontario" produced by the Ontario Ministry of Environment and Energy. The schedules are also listed in the Ontario Ministry of Agriculture, Food and Rural Affairs recommendation publications. You can also ask your supplier.

The Pesticides Act and Regulation control the use, sale, storage, display, disposal and transportation of pesticides, and fertilizers containing pesticides.

As of April 1, 1991, Schedule 1, 2 or 5 pesticide products may only be purchased and used by growers (farmers) who have been certified by taking the Grower Pesticide Safety Course. Farmers must be re-certified every 5 years.

Under the Pesticides Act, a grower (farmer) is a person who farms at least 5 hectares, or has an average annual gross revenue over three years of not less than \$4,000 from the sale of agricultural or forestry production.

You will find more details about the regulations in other sections of this manual.

Other Provincial Acts

There are three other Ontario laws that regulate the use of pesticides.

Environmental Protection Act

The purpose of the Environment Protection Act is to protect and conserve the natural environment. This Act is administered by the Ministry of Environment and Energy. It would apply to pesticides if they contaminate the natural environment in any way.

Part X of the **Environmental Protection Act** is commonly known as the "Spills Bill". It regulates the spill of any kind of pollutant.

Ontario Water Resources Act

This Act states that it is illegal to deposit in any body of water in Ontario any material that may impair the quality of the water. This Act is administered by the Ministry of Environment and Energy.

Weed Control Act (1989)

This Act requires that the person in possession of land must destroy all noxious weeds on the property. The Ontario Ministry of Agriculture, Food and Rural Affairs administers this Act.

In Ontario, some weeds are classed as noxious under the Weed Control Act. Municipalities may also add noxious weeds under the Municipal Weeds Act.

Review Questions

1. The term "PCP Act" stands for the _____
_____ Act. Which government administers this Act?

2. The PCP Act regulates products used for the control of pests. All pesticides must be registered under the PCP Act before they can be sold or used in Canada.

TRUE

FALSE

3. Once a pesticide is registered for use, Agriculture and Agri-Food Canada may review it. They may change the use, include additional precautions, or even suspend or cancel a product.

TRUE

FALSE

4. The _____ Act protects the health of consumers by preventing the sale of food that contains any harmful or poisonous substance.

5. The _____ Act is administered by Environment Canada and Health Canada. This Act controls substances which could contaminate the environment.

6. Which provincial Act regulates the use of pesticides in Ontario?

7. A home-owner may use pesticides from Schedule(s) _____.

A certified farmer may use pesticides from Schedule(s) _____.

8. What characteristics of a pesticide are considered before it is classified into one of the six Schedules?

1. _____
2. _____
3. _____
4. _____

9. The Pesticides Act and Regulation in Ontario regulate pesticide:

- a) use
- b) storage and disposal
- c) display and transportation
- d) a) and b) only
- e) all of the above

Enforcement of the Pesticides Act

The Ministry of Environment and Energy is responsible for enforcing the regulations under the Pesticides Act.

Prohibition

Prohibition (Section 4 of the Pesticides Act)

No person shall allow a pesticide to enter the environment so that it:

- impairs the quality of the environment
- damages property, animals, plants
- harms or causes material discomfort to anyone
- causes adverse health effects
- impairs safety
- makes any property, animal or plant unfit for use

If you are responsible for doing any of these things, you are subject to prosecution under the Pesticides Act. In order to stop or prevent violation of Section 4, you may be issued a Stop Order or Control Order.

Stop Order (Section 27 of the Pesticides Act)

A Stop Order is issued by the Director Under the Pesticides Act or by a provincial officer. It can be issued to prevent a person or company from handling or using a pesticide. They must stop as soon as they receive the order, and may not handle or use the pesticide again for the time period shown or until conditions of the Stop Order are met. A Stop Order can be permanent.

A Stop Order can be given if there is an **emergency** which:

- endangers the health and safety of any person
- affects the quality of the environment
- injures or damages plants or animals
- makes any property, plant or animal unfit for use

The emergency may occur while handling, storing, using, disposing, transporting or displaying pesticides.

You can **appeal** a Stop Order in writing, by agent, or by telephone, to the Director under the Pesticides Act within 15 days of the Stop Order being issued. However, the Stop Order is in effect during the appeal process.

Control Order (Section 28 of the Pesticides Act)

A Control Order is used to limit, stop or change the use of a pesticide. This kind of order may be given to a person or company if they are handling, storing, using, disposing, transporting or displaying a pesticide in a way that causes, or may cause:

- impairment of the quality of the environment
- injury or damage to property, plant or animal
- harm or material discomfort to any person
- health effects to any person
- impairment to the safety of any person
- any property, animal or plant to be unfit for use

A Control Order can be appealed by writing to the Environmental Appeal Board within 15 days of issue of the order.

Offences (Section 43 of the Pesticides Act)

Every person who contravenes the Pesticide Act is guilty of an offence. That means that you can be charged if you do not follow all of the requirements of the Act.

The penalties can be as follows:

A person can be fined a maximum of \$10,000 per day for a first conviction and a maximum of \$25,000 for following convictions.

A corporation can be fined a maximum of \$50,000 per day for a first conviction and a maximum of \$100,000 for following convictions.

In addition to these penalties, **a person** who “pollutes” (under Section 4) or has been given a Stop Order (Section 27) may go to prison for a maximum term of one year.

A corporation charged under Section 4 or Section 27 may be fined for each day the offence continues between \$2,000 and \$100,000 for a first conviction and between \$4,000 and \$200,000 for following convictions.

Review Questions

1. For an offence under the Pesticides Act, what is the maximum fine for a first conviction against:

a) a person

b) a corporation

Classification of Pesticides

In Ontario, all pesticide products are classified into one of six Schedules. The classification of pesticide products is important. It restricts the use of pesticides to people who need them and are trained to handle them properly. The pesticide vendor's licence you or your company has will tell you which Schedules of pesticides you can sell. The following chart shows how pesticides are classified by their pesticide characteristics depending on:

- how poisonous they are (toxicity)
- whether they create environmental or health hazards
- how long they last in the environment
- their concentration
- how they are used

It also shows which vendor's licence is required to sell the pesticides.

Remember:

It is illegal to sell pesticides without the proper vendor licence.

Ontario Classification of Pesticide Products

Schedule	Who Can Use It	Pesticide Characteristics*	Licence Required by Outlet
1	Restricted	Very Toxic and/or Very Persistent and/or Highly Mobile	Wholesale Retail Class 1 Sales Records Required
5	Pest Control Industry Agriculture	Very Toxic and/or Very Persistent and/or Highly Mobile less toxic or less persistent alternative not available	Wholesale or Retail Class 1 Sales Records Required
2	Pest Control Industry Agriculture	Toxic, and/or Persistent, and/or Moderately Mobile	Wholesale or (Limited Wholesale)** or Retail Class 1 or Retail Class 2 Sales Records Required
3	Consumer Pest Control Industry Agriculture	Moderately Toxic, and/or Moderately Persistent, and/or Slightly Mobile	Wholesale or (Limited Wholesale)** or Retail Class 1 or Retail Class 2 or Retail Class 3 Sales Records <u>not</u> Required
4	Consumer Pest Control Industry Agriculture	Low Toxicity Non-persistent Non-mobile Containers < 1kg < 1L	Wholesale or Limited Wholesale Vendor Licence Required No Retail Vendor Licence Required
6	Consumer Pest Control Industry Agriculture	Low Toxicity Non-persistent Non-mobile Containers > 1 kg > 1 L	Wholesale or Limited Wholesale Vendor Licence Required No Retail Vendor Licence Required

*Biological persistence and mobility in the environment
as expected under normal use conditions for Ontario

()** applies only to some of the products in this Schedule

The Ontario Pesticides Advisory Committee (OPAC) reviews the technical information on each pesticide and recommends a classification to the Minister of Environment and Energy for approval. The classification system allows Ontario to make sure that pesticides are only used by people who need them and have the knowledge to use them properly. The scheduling of products is published in the Ontario Gazette. Once published, the product can be legally sold, used, stored, displayed and transported in Ontario according to its Schedule or "Interim Schedule".

Ontario's Pesticide Schedules

Schedule	Used By
1	Licensed Applicator or Certified Farmer with Approved Permit
2,5	Licensed Applicator or Certified Farmer - No Permit Required
3,4,6	Licensed Applicator or Certified Farmer or Farmer (not certified) or Homeowner - No Permit Required

Permits

A permit is required for all applications of Schedule 1 pesticides unless exempted from the Regulation. Under the Pesticides Act, the Ontario Ministry of Environment and Energy (MOEE) may issue a permit to a person to use a pesticide on lands, water or in buildings. (Pesticides Act, s.7 & 11) Before a permit is issued, the person would have to demonstrate that he or she knows how to use the pesticide properly.

The Ontario Ministry of Environment and Energy may decide not to issue a permit or may cancel or change a permit. (Pesticides Act, s.11) The MOEE must tell you, in writing, why your permit was refused or changed. You can ask the MOEE to change their decision. The Ministry must make their decision within three days of your request. Your appeal to the Ontario Minister of Environment and Energy must be made within 15 days. You can appeal in person, by agent or in writing. You are entitled to a hearing by the Environmental Appeal Board.

The Ministry of Environment and Energy may remove a product from a Schedule at any time.

Review Questions

1. Pesticides are classified into one of six schedules, according to their characteristics. List the characteristics.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

Selling Pesticides

A person who sells pesticides has a responsible job. A vendor should be able to help the customer select the proper pesticide. A vendor should be able to give advice and assistance to customers. You may be asked to determine the application rate for a pesticide, give advice on how to handle the pesticide safely, or how to dispose of empty containers properly.

The vendor must also sell and display pesticide products according to government regulations. Following government regulations will protect your customers, your neighbours and the environment.

Licences

To sell Schedule 1, 2, 3, 5 or 6 pesticides, the vendor must be licensed by the Ontario Ministry of Environment and Energy. There are five vending licences available from the Ministry.

1. Wholesale Vendor
2. Limited Wholesale Vendor
3. Retail Vendor Class 1
4. Retail Vendor Class 2
5. Retail Vendor Class 3

The licence your business needs depends upon your customers and the Schedules of pesticides you sell.

Remember:

It is illegal to sell pesticides without the proper vendor licence.

How to obtain a vendor's licence

To obtain or renew a vendor's licence, a person must be at least 18 years of age. If a corporation or partnership needs a licence, then the director or officer of the business must be named as the official representative and must be at least 18 years of age. (Reg. 914, s. 107)

On the application form there are two questions:

1. name and address of each wholesale or retail outlet to be covered by the licence
2. name and address of at least one person for each outlet, who will be the outlet representative.

If the information changes (for example - the employee named on the form leaves the job) you must inform the Pesticides Licensing Section of the Approvals Branch of the Ministry of Environment and Energy within ten days. This is the address and telephone number:

Ontario Ministry of Environment and Energy
Pesticide Licensing and Examination Section
Approvals Branch
250 Davisville Avenue, 3rd Floor
TORONTO, Ontario
M4S 1H2
Tel: (416) 440-3713

You cannot sell pesticides unless you have an outlet representative. The only exceptions are an outlet with a Class 3 retail vendor licence, or a business that doesn't need a vendor licence (for details see Reg. 914, s. 116 & 117).

Once you have your licence, you must display it in a prominent place at each business outlet.

Who can be an outlet representative?

To be named as an outlet representative you must:

- have passed the **Pesticide Vendor Certification Course** in the past five years
- work full time at the outlet

The outlet representative may be the person who holds the licence (the Licensee), a partner with the licensee, a director or officer of the licensee's company, or an employee of the licensee.

What are the responsibilities of the outlet representative?

The outlet representative must make sure that all operations at the outlet are carried out according to the Pesticides Act and Regulation 914. This includes: making sure that all pesticides are stored, displayed, disposed of and sold according to the Pesticides Act and Regulation 914. Although the law does not require vendors to provide advice or assistance, many customers will count on you for information about pesticides.

Displaying your licence

Wholesale vendors do not require a licence for each outlet. However, the licence or a copy of the licence must be displayed at each outlet covered by the licence. (Reg. 914, s.108.)

Retail vendors need a separate licence for each outlet. The licence or a copy of the licence must be displayed at the outlet covered by the licence. (Reg. 914, s.111)

Renewing your licence

Your vendor licence is good for 5 years from the date you received it. You must apply to renew your licence at least 2 months (60 days) before the licence expires. (Reg. 914, s.9)

The fees charged for each licence type are listed under Reg. 914, s.6.

Who You Can Sell To

Wholesale Vendors (Reg. 914, s.109)

A wholesale pesticide vendor sells products to other wholesale vendors or to retail vendors. There are two types of wholesale vendor licences:

- wholesale vendor
- limited wholesale vendor

If you have either of these licences, you can operate any number of locations, but you must have an outlet representative for each location.

A person licensed as a wholesale vendor can handle all pesticide products - Schedule 1 through to 6. However, the wholesale vendor must only sell to other wholesalers or specific classes of retail vendors. The chart below gives more information.

Wholesale Vendor

Schedule	May Sell To
1,5	wholesale vendor Class 1 retail vendor
2	wholesale vendor limited wholesale vendor (only certain Schedule 2 products) Class 1 retail vendor Class 2 retail vendor
3, 4 & 6	wholesale vendor limited wholesale vendor (only certain Schedule 3 products) Class 1 retail vendor Class 2 retail vendor Class 3 retail vendor

Limited Wholesale Vendors (Reg. 914, s.110)

If you have a limited wholesale vendor licence, you are restricted to selling the less hazardous pesticides at wholesale. For example:

- Schedule 4 or 6 pesticides
- Schedule 3 pesticides that are paints, stains or wood preservatives
- Schedule 3 pesticides that are disinfectants, cleaners or bactericides
- Schedule 2 or 3 drill box seed treatments under certain packaging restrictions, and
- Schedule 2 pesticides that are bactericides used in cutting oil, marine, or aviation fuels

For more information see Reg. 914, s.110 of the Pesticides Act.

Retail Vendors (Reg. 914, s.113-116)

If you have a retail vendor licence, you will be selling to the people who use the pesticide - for example, homeowners, farmers (agriculturists), or exterminators. There are three classes of retail vendor licences in Ontario. Class 1 retail vendors are licensed to sell all six Schedules of pesticides to eligible users. Class 2 retail vendors are allowed to sell only Schedule 2, 3, 4 & 6 pesticides. Class 3 retail vendors are allowed to sell only Schedule 3, 4 & 6 pesticides. The following charts give more information.

**Retail Vendor
Class 1**

Retail Vendor Class 1

Schedule	May Sell To
1	permit holders
2,5	licensed applicators authorized to use that pesticide certified agriculturists (except picloram) weed inspectors
3	licensed applicators authorized to use that pesticide agriculturists (certified or not certified) weed inspectors homeowners
4,6	licensed applicators authorized to use that pesticide agriculturists (certified or not certified) weed inspectors homeowners

**Retail Vendor
Class 2**

Retail Vendor Class 2

Schedule	May Sell To
2	licensed applicators authorized to use that pesticide certified agriculturists (except picloram) weed inspectors
3	licensed applicators authorized to use that pesticide agriculturists (certified or not certified) weed inspectors homeowners
4,6	licensed applicators authorized to use that pesticide agriculturists (certified or not certified) weed inspectors homeowners

**Retail Vendor
Class 3**

Retail Vendor Class 3

Schedule	May Sell To
3,4,6	licensed applicators authorized to use that pesticide agriculturists (certified or not certified) weed inspectors homeowners

No Licence Needed

You do not need a retail vendor licence to sell the following:

- Schedule 4 pesticides
- Schedule 3 or 6 pesticides that are paints, stains, sealers or wood preservatives
- Schedule 3 or 6 pesticides that are disinfectants, cleansers or bactericides
- Schedule 2 pesticides for use as bactericides in cutting oils, marine or aviation fuels

This chart summarizes the Schedules of products you can sell:

Schedules of Products You Can Sell

	1	2	3	4	5	6
Wholesale	✓	✓	✓	✓	✓	✓
Limited Wholesale		★	★	✓		✓
Retail Class 1	✓	✓	✓	✓	✓	✓
Retail Class 2		✓	✓	✓		✓
Retail Class 3			✓	✓		✓
No Licence		★	★	✓		★

★ some products only

What are the vendor's responsibilities?

It is the vendor's responsibility to make sure that pesticides are sold only to authorized persons. It is illegal to sell pesticides to unauthorized persons, because they have not been trained to handle these hazardous products properly.

Most vendors know the people they sell to. However, you must ask your customers for the number of their certificate, licence or permit when required. A retail vendor should ask for an exterminator's licence number, or a farmer's certificate number. A wholesale vendor should ask for the company's type of licence and number. A questionnaire like the one on the next page makes it easy to collect the information you need.

Remember:

All vendors must keep a record of the certificate or licence or permit numbers when selling Schedules 1, 2 & 5 pesticides.

Record of Pesticide Certification Number (Sample Form)

We are authorized to sell Schedule 1, 2 and 5 pesticides **only** to farmers (see NOTE below) who hold a Grower Pesticide Safety Course (GPSC) certificate, or persons who have written permission from a certificate holder. We are required by law to keep a record of the certificate number(s) on file.

To help us serve you better, please answer the following questions. We appreciate your cooperation.

- a) What are the GPSC certification number(s) that you will use to purchase pesticides for your farm unit?

Cert #	Expiry Date	Signature of Certificate Holder
_____	_____	_____
_____	_____	_____
_____	_____	_____

- b) Please name your farm unit if it is different from the person's name on the certificate.

- c) If you have a certificate, please list the person(s) you authorize to use your pesticide certificate number.

NOTE: If you allow other people on your farm unit to use your pesticide certificate number, it means you are legally responsible for the safe transportation, storage and use of the pesticides listed on the invoice.

Authorized Persons	Signature of Certificate Holder
_____	_____
_____	_____
_____	_____

NOTE: The Pesticides Act says a **farmer** is a person who:

- uses at least 5 hectares of land for agricultural or forestry production, **or**
- uses less than 5 hectares but has an average gross annual revenue (over 3 years) of at least \$4,000 from the sale of product of agriculture or forestry production.

Who is a "certified agriculturist"?

The vendor must make sure that the farmer is a "certified agriculturist" at the time a schedule 1, 2 &/or 5 pesticide is sold. There are two parts to being a "certified agriculturist": certified and agriculturist.

To be "certified", the farmer must have passed the Grower Pesticide Safety Course within the last 5 years. (Reg. 914, s.94)

To be an "agriculturist", the farmer must be using farmland for agricultural or forestry production. A farmer must be farming:

- 1) at least 5 ha (12.35 acres); or
- 2) have less than 5 hectares but an average annual gross revenue over three years of greater than or equal to \$4,000 from the farm.
(Reg. 914, s.1)

You may ask the pesticide buyer to sign a statement to prove he or she is a "certified agriculturist". An easy way to do this is to include the following statement on the vendor's invoice or bill of lading:

I am an agriculturist who uses at least 5 hectares of land for agricultural or forestry production*, or uses less than 5 hectares but has an average gross annual revenue (over 3 years) of at least \$4,000 from the sale of products of agriculture or forestry production.

Signature: _____

Certificate # _____

*Production of Crown timber does not qualify as forestry production and the appropriate Land Class licence is required.

Permits

Under the Pesticides Act, the Ontario Ministry of Environment and Energy may issue a permit to a person to use a pesticide on land, water or in a building. (Pesticides Act, s.7).

Remember:

If you sell a Schedule 1, 2, or 5 pesticide under a permit, you must keep a record of the sale for at least three years.

Record Keeping

By law all vendors must keep a record of each sale or transfer of Schedules 1, 2 and 5 pesticide products. These records must be kept for at least three years. The sale or transfer records must include the following information:

- name and address of the person buying or receiving the pesticide
- that person's licence type and class or permit number if any
- a description of the pesticide including name, class, package size and quantity

For Retail Vendors:

If you sell or transfer Schedules 1, 2 or 5 pesticide products to a certified agriculturist, you must keep a record of the certification number.

The Ministry of Environment and Energy can ask for your records at any time. (Reg. 914, s.118)

Pesticide Display for Retail Vendors

Retail vendors should be able to show their customers the products they carry. However, they must also follow guidelines for displaying these products in order to ensure the safety of the employees and customers. The guidelines for displaying pesticides safely depend on the schedule of the products. (Reg. 914, s.125)

Display of Schedules 1, 2, 3, 4, 5 & 6

Pesticides should not be displayed in a way that could contaminate other products that are on sale nearby. Never display pesticides near food, drinks, or things like milk filters, clothing, etc. Any product that becomes contaminated could have harmful effects on people, animals or plants.

Display of Schedules 1, 2 & 5

Pesticides in Schedules 1, 2 or 5, **must not** be handled by the customer. Only the vendor or employees may handle these pesticides. Many retail vendors keep these products in a display shelf or case behind the counter where customers can not reach them.

Vendors may also set up an effective sales area by using empty packages and promotion items from the pesticide companies. This will allow the farmer to read the labels for the products on display.

Display of Schedule 3

There is only one requirement for displaying Schedule 3 pesticides because they are less hazardous. These products should be displayed at least one metre above ground level where they will present a "minimal hazard" to children. (Ontario Ministry of Environment and Energy).

Insurance

The Crop Protection Institute and the Canadian Fertilizer Institute have worked together with an insurance company to design an insurance package for distributors and vendors.

The insurance package includes a minimum of:

a) Comprehensive General Liability	\$1,000,000
b) On Site Debris Removal/Disposal	500,000
c) Off Site Pollution	1,000,000
d) Property	variable

This package covers you for:

- pollution damage which other policies do not cover
- cleanup of spills
- removal and disposal of on site debris
- work done as a custom applicator

You can purchase this package through local insurance brokers. Make sure your insurance package covers your business for pesticide accidents that might cause health or environmental damage. If an accident did happen, your company could save many thousands of dollars in cleanup costs and property damages simply by having enough insurance.

Remember:

Your insurance may not be effective if you do not follow all the regulations.

Review Questions

1. In order to purchase a Schedule 5 pesticide, a farmer must be a “certified agriculturist”. What does “certified agriculturist” mean?

2. Who can be an outlet representative according to the Pesticides Act and Regulation?

3. How should Schedule 3 products be displayed in your store?

4. What class of retail vendor licence would you need to be able to sell:
 - a) a Schedule 1 product

 - b) a Schedule 4 product

5. To whom could a Retail Class 1 vendor sell:
 - a) a Schedule 1 product

 - b) a Schedule 4 product

The Pesticide Label

Read the Label

A pesticide label gives important information. It tells you:

- what chemicals are in the pesticide
- what the hazards are when you use it
- how dangerous it is
- how to use it safely
- what to do in case of an accident

The label shows you that the pesticide is registered with the government. It also gives you the name of the company that makes the pesticide, if you need more information about it.

If all of the important information can't fit on the label, the company may include a booklet or pamphlet with the pesticide. They may also print information on the wrapper, or on stickers or tags that are attached to the container. Make sure you have all the information you need before you use any pesticide.

A pesticide label is a legal document. It tells how the product should be used. It is against the law to use it in any other way, or to use it in an unsafe way. It is also against the law for anyone to tell you that a pesticide can be used for anything that is not on the label.

Remember - Always read the label first!

- before you buy a pesticide
- before you use a pesticide
- before you store or get rid of a pesticide



2 AGRICULTURAL 3 10 L

1 CONTROL-ALL 500 E.C.

Emulsifiable Concentrate
Herbicide

READ THE LABEL BEFORE USING

KEEP OUT OF REACH
OF CHILDREN

WARNING



POISON

GUARANTEE: Monolochlor 500 g/L

REGISTRATION NO. XXXXX.
Pest Control Products Act

RIDGETOWN COLLEGE OF
AGRICULTURAL TECHNOLOGY
RIDGETOWN, ONTARIO
NOP 2C0

How to Read the Label

There are two main parts to a pesticide label. The front panel is called the **principal display panel**. The back or side panel is called the **secondary display panel**. This section will tell you what information you can find on each panel. Look at the sample labels on pages 56, 58 and 60 as each part of the label is described.

The Principal Display Panel Shows:

- 1 Product Name.** The product name includes three things:
 - a) the brand name or trade name which is registered with the government. **CONTROL-ALL** is the registered trademark of this product.
 - b) the formulation of the pesticide. This product is a liquid - an **Emulsifiable Concentrate (E.C.)**.
 - c) a description of its use. This product is a **herbicide** used to control weeds.

- 2 Classification.** This tells you how the product is used and how dangerous, or toxic, it is. The federal government has four classifications:
 - a) **Domestic.** These products are intended for use around the home. They are sold in small packages and have a low toxicity.
 - b) **Commercial** (may also be called **Agricultural** or **Industrial**). These products are not meant for use at home. They are designed for use in commercial operations, in agriculture, forestry or industry. They are stronger and have low to medium toxicity. They must be handled carefully to prevent injuries.
 - c) **Restricted.** These products can be dangerous to people, plants, animals or the environment. They often have special detailed labels to show how to handle them safely. (See page 62). You may need a provincial permit to use a restricted product.
 - d) **Manufacturing.** These products are used to create other products. They are not available to the farmer.

- 3 Net Contents.** This tells you how much of the product is in the package. The amount is shown in metric units. This label shows there are **10 L** (10 litres) in this package.



AGRICULTURAL

10 L

CONTROL-ALL 500 E.C.

Emulsifiable Concentrate
Herbicide

4 READ THE LABEL BEFORE USING

5 KEEP OUT OF REACH
OF CHILDREN

6 WARNING



POISON

7 GUARANTEE: Monolochlor 500 g/L

8 REGISTRATION NO. XXXXX.
Pest Control Products Act

9 RIDGETOWN COLLEGE OF
AGRICULTURAL TECHNOLOGY
RIDGETOWN, ONTARIO
NOP 2C0

4 READ THE LABEL BEFORE USING. This warning must be on the front panel. It is required by the Regulations of the Pest Control Products Act, a federal government law.

5 KEEP OUT-OF REACH OF CHILDREN. This warning must be on one of the panels. Here, it is on the front.

6 Warning symbols and words. The federal government uses symbols and words to show the dangers of using pesticides. All of these symbols and words, and what they mean, are shown on pages 39 and 40.

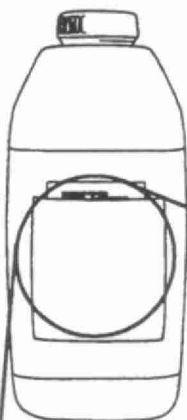
7 Guarantee. The guarantee tells you the name of the chemical that is the **active ingredient** in the product. The active ingredient is the part of the pesticide product that controls the pest.

The guarantee also shows the **concentration**, or how much of the chemical is in the product. The concentration may be measured in two ways:

- a) by the weight per unit volume. This label shows that the active ingredient is the chemical **monolochlor**. There are 500 grams of the chemical in each litre of this pesticide product (**500 g/L**).
- b) as a percentage by weight. Another label could show the concentration of the chemical as a percentage. For example, a guarantee of 40% means that in each 100 parts of a pesticide, 40 parts are active ingredient.

8 Registration Number (P.C.P. Act#). This number shows that the product has been approved by the federal government. The registration number identifies the product with the government and the manufacturer.

9 Name and address. The name and address of the company or organization that registered the product must be on the label. This company or organization is called the **registrant**. The registrant can provide more information about the product to anyone who asks.



10 DIRECTIONS FOR USE

SOYBEANS: To control broadleaf weeds and grasses, apply 1.75 to 2.5 L/ha when soybeans are at the 2 to 4 trifoliolate. Apply in 45 to 225 L of water per hectare. Do not apply when temperatures are above 25°C. Do not apply within 30 days of harvest. Do not feed treated foliage to animals.

11 PRECAUTIONS

Harmful if swallowed, inhaled or absorbed through the skin. Avoid breathing vapour or spray mist. Avoid contact with eyes, skin and clothing. Wash thoroughly after handling and before eating, drinking and smoking. Do not allow spray to contact susceptible plants. Coarse sprays are less likely to drift. Avoid contamination of food for human consumption or livestock feed. Do not contaminate water supplies or any bodies of water. Triple rinse the container. Crush or break empty container and dispose of container in an approved sanitary landfill site. Avoid freezing. If subjected to freezing temperatures, warm to at least 5°C and mix thoroughly before using.

FIRST AID:

In case of poisoning, call physician. If on skin, wash thoroughly with soap and water. If in eyes, flush with water for 5 to 10 minutes and get medical attention. If swallowed, do not induce vomiting. This product contains a petroleum distillate. Call a physician immediately.

TOXICOLOGICAL INFORMATION

Symptoms include nausea, vomiting, pin-point pupils, convulsions and coma. This product may cause cholinesterase inhibition. ATROPINE is ANTIDOTAL. Give 2 to 4 mg of atropine sulphate intramuscularly or intravenously immediately and every hour as required until pupils dilate.

NOTICE TO USER

This control product is to be used only in accordance with the directions on this label. It is an offence under the Pest Control Products Act to use a control product under unsafe conditions.

NOTICE TO BUYER (LIMITATION OF WARRANTY STATEMENT)

Seller's guarantee shall be limited to the terms set out on the label and, subject thereto, the buyer assumes the risk to persons or property arising from the use or handling of this product and accepts the product on that condition.

**The Secondary
Display Panel
Shows:**

10 **Directions for use.** The directions for use include information about:

- what pest it can be used on (weed, insect, disease)
- what crops it can be used on
- how much to use and how to mix it
- how to apply the product
- how to protect the crop
- when you should not use it
- when to harvest (pre-harvest interval, days-to-harvest, pre-slaughter)
- re-entry period (the length of time you must stay out of the treated area)
- any other restrictions

11 **Cautionary Statements.** This section tells you what hazards there are in using the product. It tells how to use the pesticide safely and how to protect yourself and others from danger.

12 **First Aid.** This section tells you what to do if someone is poisoned or injured by the pesticide.

13 **Toxicological Information.** This section gives more information on the signs and symptoms of poisoning. It also tells the doctor what antidote to use, and any ingredients that may influence the treatment. It is important to give this information to the doctor in case of an accident.

14 **Notice to user.** This section tells the person using the product to follow the directions on the label. It is against the law to use a pesticide in an unsafe way.

15 **Notice to Buyer.** This section says that the buyer is responsible for the safe use of the pesticide. Make sure that you follow the directions on the label. This notice is also called a "Limitation of Warranty Statement".

Special Labelling for Restricted Products

Look for **special directions on restricted products**. If a product has been classified as **Restricted**, the label must have a section called **Nature of Restriction** at the top of the secondary display panel, before the directions for use. This section tells you if there are special conditions for using, storing, displaying or distributing this pesticide.

Restricted Uses

The following examples show how a restricted product may be labelled.

Example 1

Nature of Restriction: Studies on the safety of this product for users and spray operators are not complete. Direction for use and precautionary statements should be followed carefully.

Example 2





Nature of Restriction: This product is to be used only in the manner authorized. Contact local pesticide regulatory authorities about use permits which may be required. This product is to be stored and displayed apart from food and feed.

Hazard Symbols & Words

What are the hazards?

Learn these symbols and words - they could save your life.



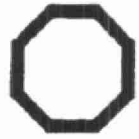
Four important symbols and words show the dangers of pesticides.

Symbol	Signal Word
	Poison
	Corrosive
	Flammable
	Explosive

Warning Symbols & Words

How dangerous are they

The hazard symbol will always appear inside one of the shapes shown below. These shapes and their warning words tell you how dangerous the pesticide is.

	Symbol	Warning Word
Triangular shape means low hazard - some danger		Caution
Diamond shape means moderate hazard - more dangerous		Warning
Octagonal shape means high hazard - most dangerous		Danger











Eye Hazards

Special Warnings for Eye Hazards

Some products can be dangerous to your eyes. The following words may appear on the label to describe the hazard:

Danger - Corrosive to eyes
Danger - Eye irritant
Warning - Eye irritant

Interpretation of Symbol Combinations

Poison Hazard:	 Danger Poison	 Warning Poison	 Caution Poison
Acute oral LD ₅₀	< 500	500 - 1,000	1,000 - 2,500
Acute dermal LD ₅₀	< 1,000	1,000 - 2,000	2,000 - 5,000
Respirator	yes	advisable in confined spaces	advisable in confined spaces
Eye Protection	yes	yes	advisable
Eye Effects	corrosive or irreversible	severe but reversible	irritation
Petroleum Distillates	10% or more	1% to 10%	—
Flammability Hazard:	 Danger Flammable	 Warning Flammable	 Caution Flammable
Liquid Products	< -6°C (20°F)	-6° to 10°C	10° to 27°C
- Flash Point		(20° to 50°F)	(50° to 80°F)
Pressurized Products	45 cm (18")	15-45 cm (6 to 18")	< 15 cm (6")
- Flame Protection			
Explosive Hazard:	 Caution Explosive		
All domestic Aerosols, Pressurized			
Corrosive Hazard:	 Danger Corrosive	 Warning Corrosive	 Caution Corrosive
acid or alkali materials	10% or more	> 5% & < 10%	> 1.5%
organic acids	20% or more	> 5% & < 20%	> 1.5%
available chlorine	—	10% liquid	> 1% solids, > 1% to > 4% liquids
pH	—	≤ 0.5 or ≥ 13.5	0.5 to 2.5 or 11.5 to 13.5

Multiple Symbols

If a pesticide is dangerous in more than one way, all the hazard symbols and words must appear on the label. However, only one warning word is required. This warning will be for the most dangerous hazard. The example below shows that fire is the most dangerous hazard.

Example:

DANGER



POISON



FLAMMABLE



EXPLOSIVE

Read the Label

Remember: - Always Read the Label First!

Each pesticide is different, and each label is different. Read the label carefully to get all the information.

Before you buy a pesticide

- Is this the right pesticide for your crop?
- What is the formulation? How do you mix it?
- How much do you need?
- How should you apply it?

Before you use a pesticide

- Are there restrictions on using this pesticide?
- When should it be used? Are there times when you should not use it?
- What are the hazards?
- What protective clothing and equipment do you need?
- What first aid is needed if there is an accident?

Before you store a pesticide or get rid of it

- What should you do with left-over pesticide?
- Where should you store it? Where should you not store it?
- How can you get rid of the container safely?

Review Question

1. The pesticide label is a legal document. It tells how the product should be used. It is against the law to use the product in any way that is not shown on the label.

TRUE

FALSE

2. What are the four federal classifications of pesticides? Circle any of the four that you could use in your garden at home.

1. _____

2. _____

3. _____






4. _____

3. The active ingredient and its concentration in the product is found in the following section of the label:

- a) the product name
- b) the net contents
- c) the warning statements
- d) the guarantee
- e) the toxicological information

4. The _____ section of the label provides additional information not given in the first aid section. It may include the signs of poisoning, the antidotes, and any ingredients in the product that may affect the treatment of poisoning.

5. What hazard and warning words would appear with each symbol below?

A.		B.		C.		D.		E.	
<hr/>									
<hr/>									

6. It is extremely important to read the pesticide label carefully. When should you read the label?

Questions 7 and 8 refer to the following examples of Multiple Symbols



7. What warning word or words would be required on a label that included all of the symbols above?

8. What hazard word or words would also be required on a label that included all of the symbols above?

Pesticide Formulations

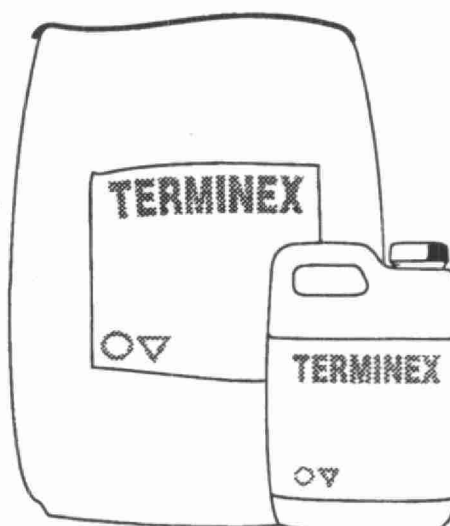
What is a formulation

Pesticides are sold in many formulations and a single pesticide may be sold in more than one formulation. A formulation is developed to make the product safer and more convenient to use.

A **formulation** consists of one or more chemicals which are the active ingredients (a.i.) plus other ingredients which have no pesticide action (inert ingredients).

An inert ingredient may be talc in a dust formulation or petroleum distillate in an emulsifiable concentrate formulation. Other inert ingredients such as solvents, wetting agents, extenders or emulsifiers may also be needed.

Some products are ready to use and require no further mixing. However most products applied in the liquid form must be diluted in water or oil before use.






The type of formulation depends on several factors:

- chemistry of the active ingredient
- toxicology of the active ingredient
- how effective the product is against the pest
- the effect of the product on the plant, animal or surface
- the effect of the product on the environment
- how the product will be applied and the equipment needed
- the application rate


Formulation Types

Formulation types can be divided into solids, liquids and gases.



 Solids	 Liquids	 Gases
Dusts or Powders, Granules, Pellets, Tablets, Particulates, Dry Flowables	Suspensions (Flowables), Solutions, Emulsifiable Concentrates	Fumigants sold as liquids or solids

The charts on the following two pages show different formulation types as well as the advantages and disadvantages of each type.

Summary of Formulation Types

Name	Description	Advantages	Disadvantages	Typical Use
 Solids				
Dry Flowable pesticides	A wettable powder which is formulated into small pellets or granules	Much less dusty than WP formulations and easier to handle	Requires agitation in spray tank	General Use
Dust or Powder	A finely ground dry material of a low concentration (a.i.) plus inert ingredients such as talc. No dilution needed before use	Ready to use	Dusty. Drifts. Can easily be seen on surface.	Spot treatment Animal powder
Granular	A mix of dry, large, free-flowing particles usually with a low concentration of a.i.	No mixing required. Ready to use. Drift minimal	Some dust. Requires special application equipment.	Soil treatment. For insect or vegetation control
Impregnated Fertilizer	Granular fertilizer containing a low amount of herbicides	One step application. Low a.i. concentration. Not dusty.	Could clog equipment	Agricultural soil application
Particulate or Bait	Mixture of large particles not recognized as a pellet or granular formulation. Mixed with edible material	Easy to spot treat	Pets and children may eat it	Bait for insects or rodents
Pellet	Preformed mixture of a.i. and inerts to form small pieces	As above	As above	Baits to control rodents, slugs
Seed Treatment	A finely ground dry material containing a dye, usually red	Colours seed so it is easy to tell it from untreated	Care must be taken with dye	Seed treatment
Soluble Powder or Granules	A dry material similar to dust or granules above except it is soluble in water	Containers empty easily. No liquid spills	Dusty	General use
Tablet	A preformed "tablet" composed of inerts and a.i.	Easy to measure and use	Accessible to pets and children	Fumigant
Wettable Powder	a.i. added to a powder (clay, talc) contains a wetting and dispersing agent. Forms a suspension in water	Containers empty easily. No liquid spills	Dusty. Requires agitation to remain in suspension	General Use

Summary of Formulation Types, Cont.

Name	Description	Advantages	Disadvantages	Typical Use
 Liquids				
Aerosol	A liquid with one or more solvents. Ready to use in pressurized containers	No mixing required - low concentration of a.i.	Pressurized containers are hazardous if punctured or heated	Flying insect control
Emulsifiable Concentrate	A clear solution with emulsifiers to be diluted in water. Final spray solution has a milky look.	A high concentration of a.i. in each container. Buy less bulk.	Possibly flammable	General Use
Micro-encapsulated Suspension	A suspension with a.i. in micro-capsules giving a slow release of a.i.	See comments on E.C.'s. Increases the residue of a.i. Reduces hazard to operator.	May be expensive	Insecticides
Suspension or Flowable	A cloudy liquid composed of solid particles of a.i. (finely ground) in a liquid. Must be diluted.	See comments on E.C.'s	Active ingredient may settle out of formulation	General Use
True Liquid/ Solution	a.i. is in solution, usually water and when mixed with water remains clear	See comments on E.C.'s. Requires little agitation when added to water in spray tank	Possibly corrosive	General Use
Ultra-low Volume (ULV) Concentrates	Solution of a.i. designed to be used undiluted only in ULV equipment. Very high concentrate of a.i.	Use without mixing	Concentration of active ingredient during application makes them hazardous. Special equipment required.	Insecticide sprays normally inside structures, also in forestry
 Gases				
Fumigants	Volatile liquids or solids packaged for release as a gas	Toxic to many forms of the pest at one time. Penetrates cracks and crevices	Area to be fumigated must be well sealed. Highly toxic.	Greenhouses Mushroom houses Other structures Bulk containers (eg. ships, rail cars)

Common Abbreviations for Formulations

Abbreviations are often used after the trade name on the pesticide label to indicate the type of formulation:

D	Dust
DF	Dry Flowable
EC	Emulsifiable Concentrate
F	Flowable
G	Granular
L	Liquid
P	Pellet
S	Solution
Sc	Sprayable Concentrate
SG	Soluble Granule
Sn	Active Solution
SP	Soluble Powder
WDG	Water Dispersible Granule
WP	Wettable Powder
WS	Water Soluble Concentrate

Not all companies use the same abbreviations. Check the label if you do not understand the abbreviation. The formulation will always be written out in full.

Adjuvants

The effectiveness of some pesticides may be improved by the addition of adjuvants to the spray mix in the spray tank.

An adjuvant is a substance added to a pesticide spray tank to improve the effectiveness of the active ingredient. One example of a commonly used adjuvant is a surfactant. Surfactants are “surface active agents”. They improve the rate at which the pesticide is absorbed.

Adjuvants may improve the effectiveness of a pesticide in the following ways:

- Wetting the surface: the spray may stick to the surface better.
- Increasing/decreasing evaporation: an adjuvant may prevent the spray from drying too fast or help it dry more quickly.
- Increasing absorption into the plant: this is important if the pesticide must enter the plant to be effective.
- Making spray droplets more uniform: this gives more complete coverage of the target surface, placing the pesticide where it can be more effective.

Pesticide Compatibility

Pesticides are considered compatible if they mix well in the spray tank and work effectively together. Do not use pesticides together if you see separation, coagulation, gelling or curding when they are mixed. These pesticides are not compatible.

Before combining pesticides, be sure they are compatible. Check the label for information about compatible products or refer to compatibility charts available through government extension services.

Do not use a mixture if it is not on the label or recommended in a government publication. Combining two chemicals which are incompatible is costly and time consuming.

Do not mix more than two pesticide types. Cocktail mixtures of pesticides give poor results and may damage your crop.

Review Questions

1. You can get only one formulation of any pesticide because it is safer and more convenient.

TRUE

FALSE

2. A formulation consists of one or more active ingredients plus inert ingredients.

TRUE

FALSE

3. Formulations can be divided into three common groups. Name these groups.

1. _____
2. _____
3. _____

4. Match the following abbreviations with the type of formulation it stands for:

EC _____

WP _____

F _____

G _____

Sc _____

SP _____

a. sprayable concentrate

b. flowable

c. emulsifiable concentrate

d. soluble powders

e. wettable powders

f. granular

g. dry flowable

h. water soluble concentrate

5. State one advantage of using an emulsifiable concentrate.

6. State one disadvantage of using a fumigant.

7. The term adjuvant means a:

- a) finely ground dry material containing a dye, usually red
- b) suspension with the active ingredient (a.i.) in micro-capsules giving a slow release of the a.i.
- c) mix of dry, large, free flowing particles usually with a low concentration of a.i.
- d) wettable powder formulated into small pellets or granules
- e) substance added to a pesticide spray tank to improve the effectiveness of the a.i.

8. When compatible pesticides are added to a spray tank and mixed, they tend to separate, coagulate, gel or curd.

TRUE

FALSE

9. The pesticide label contains information about which products are compatible.

TRUE

FALSE

The Material Safety Data Sheet (MSDS)

The first place to look for information about a pesticide is on the product label. The second place to look is the Material Safety Data Sheet (MSDS).

The MSDS gives information about health hazards, personal safety and environmental protection. Material Safety Data Sheets are organized into 9 sections. The order in which the sections appear will vary from company to company. Read the MSDS to find out about the products you work with.

Material Safety Data Sheet

Ridgetown College of Agricultural Technology
Ridgetown, ON N0P 2C0
Emergency Number - 24 hours: 519-674-SSSS

1 Product Identification

Page 1 of 2

Trade Name:	CONTROL-ALL 500 EC
Active Ingredient:	monolochlor, 500 g/L emulsifiable concentrate
Chemical Identity:	3-(1-methylethyl)-2H-2,1-monolochlor
Formula:	500 g active ingredient/L
CAS No.:	(active ingredient): 10101-22-3, PCP No. XXXXX
Use:	herbicide to control broadleaf weeds and grasses
TDG Classification:	Not regulated.

2 Hazardous Ingredients

monolochlor aromatic hydrocarbon solvent	500 g/L active ingredient 40%
---	----------------------------------

3 Physical Data

pH:	8 - 8.5
Odour:	aromatic odour
Form:	Liquid
Water Solubility:	miscible EC formulation
Boiling Point:	86° C
Specific gravity:	1.002

4 Preventative Measures

Personal Protective Measures:	respirator; neoprene gloves; goggles or face shield
Preventative Measures:	Do not smoke, eat or drink while working with this product and wash thoroughly before doing so.
Technical Protective Measures:	Avoid breathing vapours, ventilate enclosed spaces and wear cartridge type respirator.
Special Precautions for Transport:	Keep containers tightly closed when not in use.
Storage Precautions:	Do not handle or store near flame, heat or strong oxidants. Do not store near food or animal feed. Avoid freezing temperatures.

5 Emergency and First-Aid Procedures

Spills:	Before handling any spills, follow the safety measures above. For small spills, absorb with sand or other non-combustible material like clay or kitty litter. For large spills, dike up and contain the spill. Collect into a suitable container. Absorb the rest with sand, earth or clay. Decontaminate the area and equipment with laundry bleach or hydrated lime.
Disposal:	Dispose in accordance with local regulations. Mixing with a strong alkali like lime or caustic soda speeds up degradation. Empty containers should be triples rinsed and destroyed in a manner that is approved by the provincial Ministry of Environment. Do not reuse empty containers.

1 Product Identification

This section gives the trade name, chemical name, and primary use of the product. It also gives the name, address and emergency telephone number of the manufacturer and supplier.

2 Hazardous Ingredients

This section explains what the active ingredient is, and may tell you what other ingredients are included. It gives the chemical registration numbers and transportation classification for the product. (There may be a separate section for the transportation classification).

3 Physical Data

Information in this section includes appearance, odour, specific gravity, boiling point, pH, etc.

4 Occupational Procedures/Preventative Measures

This section explains what personal protection you must use - such as eye protection, skin protection and respirator protection. It also gives safe handling and storage procedures.

5 First Aid and Emergency Procedures

This section explains what to do if someone is exposed to the product. Follow these instructions in an emergency, but always call for medical help.

Material Safety Data Sheet

Ridgetown College of Agricultural Technology
Ridgetown, ON N0P 2C0
Emergency Number - 24 hours: 519-674-SSSS

5 Emergency and First-Aid Procedures Continued

Page 2 of 2

Skin Contact:	Immediately remove contaminated clothing and wash affected skin with soap and water.
Eye Contact:	Flush eyes with plenty of water for 15 minutes and seek medical advice immediately.
Inhalation:	Remove victim to fresh air and if breathing has stopped, give artificial respiration. Seek medical attention.
Ingestion:	If swallowed, do not induce vomiting but rush victim to nearest hospital taking the container or this sheet with you. Use gastric lavages and saline cathartics.

6 Fire and Explosion Hazard

Flash Point:	70 ° C
Ignition Point:	N/D
Extinguishing Media:	Water spray, dry powder, foam
Special Precautions:	Use water spray to cool off fire exposed surfaces and to protect personnel. Respiratory protection required for fire fighters. Prevent fire run-off from entering lakes or streams.

7 Toxicity and Health Effects

Acute Oral LD₅₀:	756 mg formulated product/kg bodyweight (rats)
Acute Dermal LD₅₀:	1480 mg active ingredient/kg bodyweight (rats)
Dermal irritation:	mild irritant (rabbit)
Inhalation LC₅₀:	>4.6 mg formulated product/litre air
	KEEP OUT OF REACH OF CHILDREN. May cause irritation to eyes, nose, throat and skin. Do not breathe spray mist. Harmful by inhalation, in contact with skin and if swallowed.

8 Reactivity Data

Stability:	stable
Hazardous polymerization:	will not occur
Incompatibility:	Avoid contact with strong acids, alkalis, and strong oxidants; nitric acid, acetaldehyde, hydrogen peroxide, chlorinated compounds
Hazardous Decomposition Products:	Thermal decomposition may produce toxic smoke, CO and CO ₂

9 Preparation Information

Preparation Date:	94/08/11
Supersedes:	92/05/24
Telephone Number:	519 - 674 - ZZZZ
Manufacturer/Distributor:	Ridgetown College of Agricultural Technology, Ridgetown, ON N0P 2C0

The above information is intended to describe our product in respect to safety and handling requirements only. We have attempted to be complete and correct however liability for any damage or injury is hereby declined since conditions of use and utilization of the product are beyond our control. Observance of all legal requirements is the responsibility of the user.

6**Fire & Explosion Hazard**

This section tells you whether a product will catch fire or explode. Make sure you give the local fire department the MSDS for all the products you use. This information will help them deal with an emergency.

7**Toxicity/Health Effects**

This section tells you how your health may be affected by exposure to the product. It gives results of the company's research on the product. It is also called toxicological data. This information can help a doctor deal with an emergency.

8**Reactivity Data**

This section gives any special chemical properties of the product. It will also tell you the temperature for storage of the pesticide.

9**Preparation Date & Group**

This section tells you who prepared the MSDS and the date it was prepared. Make sure your MSDS was prepared in the last three years.

You may also find another section with additional information on any of the sections listed above. For example: first aid, protective equipment, or environmental toxicity.

The organization of a MSDS will be slightly different for each company.

If you cannot find the information you need on the label or MSDS, contact the company. Make sure you understand the information on the label and the MSDS before you use a pesticide. Your safety depends on handling pesticides properly.

Material Safety Data Sheets can be obtained from:

- pesticide manufacturers or
- suppliers.

Contact your pesticide sales representative if you would like to obtain a MSDS for a product that you use.

Review Questions

1. When would you refer to a Material Safety Data Sheet?
2. Where can you obtain a Material Safety Data Sheet?

Risk of Pesticide Use

Each time a grower handles a pesticide there is some risk. The risk is that you may be exposed to the chemical and that you may be harmed by it. The amount of risk depends on two things - the exposure to the product and its toxicity. Risk can be expressed as:

$$\text{Risk} = \text{Exposure} \times \text{Toxicity}$$

How do chemicals enter the body?

You may be exposed to a pesticide in three ways:

- by swallowing a substance (**oral exposure - ingestion**)
- by contact with the skin and eyes (**dermal exposure**)
- by breathing in spray mist, dust or vapours (**respiratory exposure - inhalation**).

Exposure

These three ways that pesticides can enter the body are called the **routes of absorption**.



Oral exposure occurs when a person **swallows** a toxic substance. This may happen accidentally or because food has been contaminated by pesticides. Oral exposure is often the result of carelessness - for example, blowing out a plugged sprayer nozzle or smoking or eating without washing the hands first. The most common reason why someone swallows a pesticide solution is that the pesticide has been removed from its original container and stored in liquor, soft drink or food containers.



Dermal

Dermal exposure occurs when a substance comes in **contact** with exposed skin or eyes. It can occur easily through direct contact with the pesticide concentrate or solution, or with the spray mist during spraying. Another common cause of exposure is wearing contaminated clothing.

Dermal exposure is the most common kind. The amount of pesticide taken into the body depends on several things. Skin rashes, broken skin or abrasions may increase the rate of intake. There is less intake of powders than liquids. Oil solutions may be more easily absorbed than water solutions.



Respiratory

Respiratory exposure occurs when a person **inhales** (breathes in) small spray particles, dust gases or vapours. There is more chance of inhaling pesticides when working in a confined or poorly ventilated area.

Because the surface of the lung is a very thin membrane, it allows chemicals to enter the bloodstream quickly. The lungs may also be damaged by inhaling some chemicals.

Toxic pesticides - handle with care!

It is possible to use a highly toxic pesticide without any harmful effects, but you must handle it with care. You can reduce your chance of exposure to pesticides by wearing the protective clothing and equipment suggested on the label and by learning how to handle pesticides carefully.

Remember that the danger of exposure to a pesticide is not confined to the user. Others can suffer as well - the user's family or co-workers, consumers of the product and the environment. You can reduce the dangers for each of these groups by using pesticides wisely and according to label directions.

How toxic are pesticides?

Toxicity is the measure of how harmful or poisonous a substance is. Pesticides vary from being slightly toxic to being extremely toxic.

Before a pesticide product is approved by Agriculture and Agri-Food Canada, it must be tested to determine how dangerous it is for:

- a single dose or exposure, and
- repeated exposures to small doses.

Acute toxicity is the toxic response that results from a **single** dose or exposure to a pesticide.

Chronic toxicity is the toxic response that results from **repeated** exposures to small doses of a pesticide over a longer period of time.

Acute Toxicity

Scientists measure the acute toxicity of a pesticide by determining its lethal dose 50% or LD_{50} .

Lethal Dose 50% (LD_{50})

The LD_{50} value is the statistical estimate of a chemical dose which will kill 50% of the test animals within a stated period of time (24 hours to seven days). The test animal is usually a rat, mouse or rabbit.

Since pesticides can enter the body by three different routes, the LD_{50} for each route must be measured.

Oral LD_{50} is the amount of a substance (mg/kg of body weight) which will kill 50% of the test animals when it is ingested orally (swallowed).

Dermal LD_{50} is the amount of a substance (mg/kg of body weight) which will kill 50% of the test animals when it is applied to the skin.

Inhalation Toxicity LC_{50} (Lethal Concentration 50%) is the concentration (expressed in parts per million) of a vapour in air which will kill 50% of the test animals when it is inhaled (breathed in) over a set period of time.

The larger the LD_{50} value, the less toxic the pesticide. **Pesticides with low LD_{50} values (0-10) are extremely toxic.**

Pesticide (active ingredient)	Acute Oral LD₅₀ (mg/kg)	Toxicity
brodifacoum	0.27	high
MCPA	700 - 1,000	medium
metribuzin	1,937 - 2,345	low
glyphosate	4,320	low

Information on Oral LD₅₀ levels is usually available from the dealer or manufacturer in the form of a **Material Safety Data Sheet (MSDS)**. The LD₅₀ value for the formulated product is usually on the MSDS for that product.

However, information on the Oral LD₅₀ is not enough to tell you how toxic the pesticide is. You must also know the toxicity for dermal and inhalation absorption.

You can find out how toxic a pesticide is by reading the label on the product. Symbols and words show the acute toxicity of the product (see "The Pesticide Label" section).

Chronic Toxicity

Acute toxicity does not give complete information about the dangers of a pesticide. You also need information about the effects of long-term exposure, or its chronic toxicity.

It is not possible to assess chronic toxicity of a pesticide in the same way as acute toxicity is measured. Instead, a number of different tests are performed on animals. These tests help to predict whether a pesticide will cause long-term effects.

Test animals are exposed to low levels of pesticides for periods ranging from about 90 days to several years. The tests may use oral, dermal or respiratory exposure. The animals are examined to determine whether the exposure has caused any toxic effects.

Remember that the symbols on the label do not give information about the chronic toxicity of the pesticide. The label may include a written warning about the product's ability to cause chronic effects.

Remember

Pesticides are not only toxic to humans. They can be even more dangerous for fish and birds and other wildlife. Follow all label precautions to protect yourself, others, and the environment.

Review Questions

1. Chronic toxicity of a pesticide refers to the toxic response resulting from a single dose or exposure to a pesticide.

TRUE

FALSE

2. An LD_{50} value is defined as:

- a) the lowest dose required to kill 50 rats in a test population
- b) the dose required to kill a population of test animals under experimental conditions
- c) the legal dose acceptable for use
- d) the dose required to kill 50% of a population of test animals within a given period of time
- e) 50% of the dose required to kill a population of test animals under experimental conditions

3. Based on the given LD_{50} values, which of the following pesticides is the **least** toxic?

- a) 53 mg/kg
- b) 1,870 mg/kg
- c) 294 mg/kg
- d) 195 mg/kg
- e) 560 mg/kg

4. When handling pesticides the risk involved depends on:

- a) the toxicity of the pesticide being used
- b) the user's exposure to the pesticide
- c) the toxicity of the pesticide, together with the amount of exposure the user has to the pesticide
- d) the safety steps followed during the mixing and loading operation, since this is when pesticides are in a concentrated form
- e) how high the LD_{50} value of the pesticide is

5. What are the three possible routes of absorption of pesticides into the body?

1. _____
2. _____
3. _____

6. The LD₅₀ value is used to determine the (ACUTE - CHRONIC) toxicity of a pesticide and not the (ACUTE - CHRONIC) toxicity of a pesticide. **(Circle the correct answer)**

7. How could you, as a pesticide user, try to prevent the accidental oral intake of pesticides on your farm?

8. Dermal exposure is the most common reason for pesticide poisoning. State one way you can protect yourself from dermal exposure.

9. State 2 precautions a pesticide user would take to avoid inhalation of a pesticide.

1. _____
2. _____

Pesticide Poisonings

All pesticides are poisons. They are used to control or kill specific pests like weeds, insects, fungi or rodents, but they can affect humans too. Some pesticides are more poisonous (toxic) than others and a small dose will produce harmful effects. Other pesticides are less toxic and a larger dose is necessary to cause any effect. But, no matter how toxic, all pesticides are poisonous. You should always take precautions to protect yourself, and others, from being exposed to pesticides.

Poisoning Statistics

More than 2,500 cases of pesticide poisonings were reported in Canada in 1987. Approximately 300 were reported from Ontario. More than half of these poisonings happened to children under the age of four.

How do accidental poisonings occur?

Pesticides can enter the body in three ways:

- through the skin and eyes (absorption - dermal exposure)
- through the mouth (ingestion - swallowing)
- through the lungs (inhalation - breathing in)

It is possible to be poisoned by a pesticide, without realizing that the pesticide has entered your body.

Through the Skin (Dermal exposure)



Poisoning can result when a pesticide enters the body through contact with the skin. This is the most common kind of exposure. How much your body will absorb (**absorption**) depends on - the condition of your skin, the part of the body contacted and the kind of pesticide. The **absorption rate** describes how fast your body takes in the pesticide.

Your body will take in pesticides more easily if:

- You have cuts, scrapes or abrasions on your skin.
- Your skin is moist or sweaty.
- The pesticide stays on your skin for a long time.
- Certain parts of the body are exposed. For example, the absorption rates for the insecticide parathion are:
 - ear canal 47%
 - scalp 32%
 - palms of the hand 12%
 - forearm 8.6%
 - eyes and scrotal area 100%
- The pesticide contains solvents that help it enter the body. For example, emulsifiable concentrates (E.C.) may be absorbed more easily than granular pesticides because they contain solvents.

Eyes

Give special attention to protecting your eyes. Although eyes are only a small part of the total skin on your body, they absorb pesticides quickly. Some pesticides irritate the eyes. They may cause severe damage if they get in the eyes.

To Prevent Absorption Through the Skin:

- Always wear protective clothing, including gloves, when handling or using pesticides.
- Wear protective clothing, including gloves, when repairing equipment contaminated with pesticides.
- Wash and shower as soon as possible after using pesticides.
- Wash before eating, drinking or smoking.
- If you spill pesticides on your body or clothes, shower and change clothing immediately.

- Do not go back into a sprayed field until the re-entry time shown on the label has passed. If there is no recommended re-entry time, wait until the spray droplets have dried.
- Wash clothes used during pesticide application separate from other laundry after each day of spraying.
- Always remember to wear goggles or a faceshield when mixing pesticides or loading tanks to protect your eyes from splashes and spills.

Through the Mouth (Ingestion)



Poisoning can result from pesticides entering the body through the mouth. This can happen if:

- A pesticide is put in a food or drink container. A person may eat or drink the pesticide by mistake.
- A pesticide is stored in a container that is not labelled properly.
- A person smokes, eats or drinks while spraying pesticides.
- A person eats some food that has recently been treated with a pesticide.

Because the stomach and the intestines absorb chemicals quickly, the poisoning may be very serious.

To Prevent Ingestion

- Store pesticides in their original containers, away from children or unauthorized persons. Make sure the original label can be read.
- Never store pesticides in food or drink containers.
- Wash after handling pesticides and before eating, drinking and smoking.
- Never use your mouth to siphon pesticide liquids or to clean clogged sprayer nozzles.
- Use a face shield when mixing concentrates.

Through the Lungs (Inhalation)



Poisoning can result from pesticides entering the body through the lungs. Once pesticide is in the lungs, it is absorbed almost completely. Most small particles and spray droplets are too large to enter the lungs directly. However, they will build up in your nose and nasal passages. They may eventually enter the body through the saliva in your mouth. Small spray droplets are a greater inhalation hazard than larger droplets. They are easier to inhale, and can enter the lungs directly. Inhalation is the biggest danger when applying fumigants.

To Prevent Inhalation:

- Wear a respirator when necessary. Make sure it is the correct type and that it fits properly.
- Do not smoke while applying pesticides and do not use contaminated smoking supplies.
- Do not go back into a treated area or room too soon. Follow the directions on the label or, if no re-entry time is listed, wait until the spray droplets have dried.

Learn the Symptoms

Learn to recognize the symptoms of pesticide poisoning.

Remember

Act quickly - Mild symptoms can quickly change to severe symptoms. Stop the exposure and call for medical help.

Stay calm - Severe symptoms do not always mean that the patient is severely ill. Get medical help as soon as possible.

Mild Symptoms: Headache, fatigue (tired feeling), loss of appetite, dizziness, weakness, nervousness, nausea, perspiration, diarrhoea, loss of weight, thirst, moodiness, irritation of the skin, eyes, nose or throat.

Moderate Symptoms: Nausea, trembling, loss of muscular coordination, excessive saliva, blurred vision, constricted throat or chest, laboured breathing, flushed or yellow skin, abdominal cramps, vomiting, diarrhoea, mental confusion, perspiration, rapid pulse, cough.

Severe Symptoms: Vomiting, loss of reflexes, not able to breathe or increased breathing rate, muscle twitching, tiny pupils, convulsions, unconsciousness, thirst, fever.

Always read the Toxicological Section of **each** pesticide's label **before** you use it. This section lists the specific poisoning symptoms to watch for. You will need this toxicological information for the doctor if a poisoning occurs.



Don't Waste Time

Symptoms will vary with the pesticide, the exposure and the individual. Sometimes the symptoms of pesticide poisoning may be confused with the symptoms of food poisoning, asthma, flu and other illnesses. So, if you, or anyone else, has been exposed to a pesticide, and shows any of these poisoning symptoms, call a doctor, and go to the hospital. **Don't wait.**

Pesticide Sensitization and Allergic Responses

Some people are more sensitive to certain pesticides than others. One person may develop symptoms from a pesticide while a fellow worker is not affected. Sometimes a person will show no reaction to a pesticide when first exposed to it, but months later when exposed again, that same person may react. Keep track of the chemicals you work with, so you will know if you are becoming sensitive to any of them.

Some pesticides cause skin irritations or dermatitis when they are used in bright sunlight. Watch for this reaction if you are using pesticides such as captan, treflan and atrazine.

Acute and Chronic Poisoning

There are two kinds of poisoning, acute and chronic.

- **Acute poisoning** occurs from a single dose or exposure. Symptoms are usually immediate and severe.
- **Chronic poisoning** occurs when a person is exposed to many small doses of pesticide over a longer period of time. Symptoms appear when a sufficient amount of the pesticide builds up in the body.

It is helpful to know about the chemical family a pesticide belongs to. Pesticides in the same chemical family have similar effects on the body.

Chemical Families

There are three chemical families which often cause pesticide poisonings:

1. **organochlorine insecticides (OC)**
(also called **chlorinated hydrocarbons (CHI)**)
2. **organophosphorus insecticides (OPI)**
3. **carbamates (C)**

1. **Organochlorine Insecticides (OC)**
(also called **chlorinated hydrocarbons (CHI)**)

Examples: methoxychlor
endosulfan (THIODAN)
lindane

Type of Poisoning: **Chronic**

Poisoning results from frequent exposure to small doses over a period of time. These pesticides build up in the fatty tissue of the body. The amount of time it takes for poisoning to occur depends - on the dose, frequency and length of time of the exposure.

Effects:

Organochlorines act on the nervous system. How this occurs is not known.

2. **Organophosphorus Insecticides (OPI)**

Examples: azinphos-methyl (GUTHION)
fonofos (DYFONATE)
parathion
chlorpyrifos (LORSBAN)
diazinon
fenthion (SPOTTON)

Type of Poisoning: **Acute** (most common)
 Chronic (limited situations)

How severe the poisoning is depends on how quickly the pesticide is broken down in the body. If it is broken down quickly, the pesticide will not cause severe damage to the nervous system. Chronic poisoning may occur from working in storage areas that are not ventilated properly.

Effects:

OPI's affect the nervous system by reducing the cholinesterase level in the blood. The section on Cholinesterase Levels describes how this happens and what to do. Generally, long term effects are minimal unless exposure is continuous.

3. Carbamate Insecticides (C)

Examples: carbaryl (SEVIN)
methomyl (LANNATE)
carbofuran (FURADAN)
bendiocarb (TRUMPET)

Type of Poisoning: Acute

Effects:

Carbamate insecticides affect the nervous system by reducing the level of cholinesterase in the blood. The effects of carbamate exposure last for a shorter time than exposure to organophosphorus insecticides, because the cholinesterase level recovers more quickly after carbamate exposure.

Other Chemical Families

Other pesticides which do not belong to the three chemical families listed above also have high acute toxicities. They have been the cause of a number of poisonings.

Dinocap belongs to the dinitrophenol family. It is most toxic when swallowed, but it can also be taken in by the lungs and skin. A single large dose can cause immediate severe symptoms. Chronic poisoning can also occur.

The herbicides diquat and paraquat belong to the bipyridylium family. They can cause death if they are swallowed, inhaled or absorbed through the skin.

**Avoid
Pesticide
Poisoning**

If you handle pesticides carefully, you can reduce the risk of pesticide poisoning. But don't think you're totally safe just because you have never experienced acute poisoning symptoms. We don't yet know all the effects of long term exposure to pesticides. Always use protective clothing and equipment, and always take special care when handling any pesticides.

Cholinesterase Level

Organophosphorus and carbamate insecticides affect the nervous system. They prevent signals from being transmitted accurately from the brain to various parts of the body. They change the level of the enzyme, **acetyl cholinesterase**, which is needed to send the message properly.

How does this happen?

To transmit a message from the brain, a signal passes from one nerve fibre to another over a gap called a synapse. To send the message across the synapse, a chemical, called acetylcholine, is released at one nerve ending. This chemical stimulates the next nerve ending to get ready to receive the message.

Once the message has been received by the second nerve ending, the message is stopped by an enzyme called **acetyl cholinesterase**. If acetylcholine is not broken down, the message continues to be sent to the muscles, over and over again.

If organophosphorus or carbamate insecticides are in the body they combine with the **acetyl cholinesterase**. This prevents the enzyme from stopping the acetylcholine message. The message is sent over and over again across the synapse. This causes the muscles to twitch constantly. It can cause the person to have convulsions or "fits".

Organophosphorus insecticides form a strong bond with the acetyl cholinesterase. Carbamates form a weaker bond. However, it does not matter which of these chemicals a person has been exposed to, you must act quickly to prevent damage.

What should you do?

Remove the victim from the source of exposure and get medical help right away. The antidote, ATROPINE, given by a doctor will return the level of cholinesterase to the level before exposure. The person should be kept away from the pesticides until the cholinesterase level returns to normal. A blood test must be done to monitor the level of cholinesterase.

Cholinesterase Blood Test

Any person who handles or applies organophosphorus or carbamate insecticides often should have regular cholinesterase blood tests. The first test should be taken before any exposure to these pesticides. That will show the normal, or base, level of cholinesterase in the body.

During the spray season, when a person may be spraying organophosphorus or carbamate insecticides regularly for several weeks, a test should be taken **every seven to ten days**.

A test should also be taken after exposure is completed. This test will show whether your cholinesterase levels are back to normal. Any doctor can arrange these tests for you.

What do the tests show?

The first test shows the normal level of cholinesterase in the body. After exposure, the test shows whether the cholinesterase level has been reduced by the chemicals. If the level is less than half of the normal level, the person is showing signs of pesticide poisoning. He or she should be removed from exposure until the level has returned to normal.

Why have regular tests?

Most chemical companies that manufacture or use organophosphorus and carbamate insecticides require their employees to have regular blood tests. It is a routine procedure which is just one part of a company's complete safety program. The blood test helps a doctor diagnose the signs of pesticide poisoning. It can also be a warning to the operator that more safety precautions are needed. Call your doctor to arrange for a blood test.

Prevention

The best protection from accidents is prevention. To prevent accidental poisoning, take the following precautions:

- keep all pesticides **out of reach of children**
- store pesticides properly
- dispose of unused pesticides properly
- keep pesticides in original containers with labels intact - make sure the labels can be read
- do not re-use food or drink containers for pesticides
- read the label - follow all directions
- destroy food or other items you suspect have been contaminated
- do not eat, drink or smoke when using pesticides
- provide good ventilation when using pesticides
- use protective clothing and equipment

Review Questions

1. Absorption through the skin may be increased if:

- a) the skin has cuts, scrapes or abrasions
- b) the skin is moist or sweaty
- c) you wear contaminated clothing
- d) all of the above
- e) both a) and b) are correct

2. When a pesticide enters the body through the mouth, it is absorbed quickly through the stomach and intestines. Poisoning can be severe and may cause serious illness.

TRUE

FALSE

3. Why are small spray droplets a greater inhalation hazard to a pesticide user than larger spray droplets?

4. Symptoms of a mild pesticide poisoning include:

- a) headache, fatigue and nausea
- b) trembling, blurred vision, laboured breathing
- c) constricted pupils, convulsions, muscle twitching
- d) irritation of skin, eyes, nose and throat
- e) both a) and d) are correct

5. The symptoms of pesticide poisoning may be confused with symptoms of food poisoning.

TRUE

FALSE

6. Circle the correct word to complete the sentences below:

(ACUTE - CHRONIC) poisoning occurs when a person is exposed to many non-poisonous doses of a pesticide over an extended period of time.

(ACUTE - CHRONIC) poisoning occurs from a single dose of a pesticide with the symptoms usually being severe and immediate.

7. Name the three chemical families which are often the cause of pesticide poisonings.

1. _____
2. _____
3. _____

8. Organochlorine insecticides accumulate in the fatty tissue of the body and act to destabilize the nervous system.

TRUE

FALSE

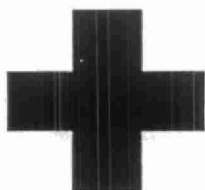
9. Not all of the long term effects of pesticides are known and precautions should be used when handling any pesticides.

TRUE

FALSE

10. Any person who regularly handles or applies OPI's and carbamates should obtain a _____ test. When should it be done?

1. _____
2. _____
3. _____



Emergency Action

First Aid

In spite of all precautions, pesticide accidents can still happen. Learn the signs of poisoning and find out what to do in an emergency. If an accident happens, stay calm and act quickly. Prompt action may save a life.

If an Accident Happens . . .

1. Protect yourself from injury. Always put on protective clothing and equipment before entering a contaminated area or handling a patient.
2. Stop the exposure. Move the patient away from the contaminated area and remove all contaminated clothing. Use soap and water to wash skin that has been exposed to the pesticide.
3. Determine the route of entry for the pesticide (mouth, skin, or lungs). Start the first aid treatment for that route of entry.
4. Check for the Four Basic Facts described on page 82. You will need this information when you call for medical aid.
5. Call a doctor, an ambulance and the Poison Information Centre, as soon as possible.
6. Make sure the patient gets medical aid.

First Aid Treatment for Pesticide Accidents

The first aid treatments outlined in this section will help you deal with pesticide accidents. Remember that first aid information is on the label of every pesticide product. The location of the information and details will change for each pesticide, so read each label carefully. Be sure that you know the first aid treatment **before** using a pesticide, and show someone else the information too.

The first aid treatment that you use will depend on the route of entry of the pesticide. The patient may have breathed in the pesticide (lungs), swallowed it (stomach), or taken it in through his skin or eyes.

This section tells you what to do while you wait for medical help. **Be sure to call a doctor, ambulance, or the Poison Information Centre as soon as possible.**

If Pesticide Contacts Skin

- Remove contaminated clothing.
- Rinse skin with plenty of water.
- Wash skin, hair, and nails thoroughly with lots of soap and water. Repeat.
- Dry victim and if necessary wrap in a blanket.
- Get medical attention.

For Chemical Burns on Skin

- Remove the chemical immediately to stop the burning. Do not wait for clothing to be removed.
- Brush dry chemicals off skin and clothes and away from the victim, then rinse with lots of water.
- For liquid chemicals, rinse with large amounts of water.
- Keep flooding the area with water while removing clothing. Do not remove clothing that is stuck to the skin.
- Immerse burned area in ice water or place cold packs on area.
- Cover with a loosely applied clean cloth.
- Get medical attention.

Do Not: touch the burned area
remove clothing stuck to the skin
break blisters
use ointments or lotions

If Pesticide Contacts Eyes

- Hold eyelids open and wash with large amounts of clean running water.
- Wash for fifteen minutes or more.
- Get medical attention.

If Pesticide was Inhaled (dusts, vapours, gases)

- Always put on protective equipment before entering a contaminated area.
- Move the victim to fresh air.
- Loosen tight clothing.
- Give artificial respiration if needed to keep the victim breathing
- Get medical attention.

If Pesticide was Swallowed

- Check the label for first aid directions. Induce vomiting **ONLY** if the first aid section of the label says that you should.
- Call a doctor and/or the Poison Information Centre immediately.

Do Not Induce Vomiting When:

- Patient is unconscious or in a coma.
- Patient is in convulsions.
- Patient has swallowed petroleum products (products containing oils such as Emulsifiable Concentrates).
- Patient has swallowed a corrosive poison (strong acid/alkaline products).



To Induce Vomiting

A. Under the direction of a doctor or Poison Information Centre

Give syrup of ipecac - 15 mL (1 tablespoon) to children, 30 mL (2 tablespoons) to adults. Follow with one to two glasses of water or fruit juice. Repeat in fifteen minutes if vomiting has not happened. One-dose bottles are available at most drugstores.

B. Without the direction of a doctor

Give the **conscious, unconvulsive**, patient several glasses of warm water to drink. If this does not work, tell the patient to tickle the back of his throat with **his own** finger. Vomiting caused by tickling is usually not complete and the patient must be seen by a doctor as soon as possible.

Keep the patient lying down with his head below the level of his feet. This position allows the vomit to drain away from air passages. If you do not know what the poison is, be sure to collect some of the vomit for the doctor.

Four Basic Facts



Four Basic Facts are needed to give fast and effective treatment to a poison victim. The doctor, ambulance, or Poison Information Centre will ask you for this information when you call. Collecting this information will not take long, and it is important.

- 1 **Identify the product.** The PCP Act registration number on the label identifies the product. Look for the container, the label, or left-over pesticide. If necessary, the patient's vomit can even be used to identify the poison. The manufacturer of the product may also give emergency information. Some companies list a 24 hour emergency number on the label.
- 2 **Determine the quantity taken.** Estimate how much may have been taken. This will help determine how serious the accident is.
- 3 **Determine the route of entry.** The route of entry can be through the mouth, skin, or lungs. The first aid you do will depend on how the pesticide entered the body.
- 4 **Determine the time period.** How long was the patient exposed to the pesticide? Is the poisoning a result of continued use over a number of years or were the symptoms immediate?

If you can't find out all four facts, **do not waste time**. Provide whatever information is available to the doctor, ambulance, and/or the Poison Information Centre. Follow the advice of the medical personnel.

Emergency Numbers



The Poison Information Centre number is listed in the front page of the telephone book.

There are two Poison Information Centres in Ontario. They provide information on all types of poisonings, including pesticide poisonings:

TORONTO: Hospital for Sick Children
(416) 813-5900
1-800-268-9017

OTTAWA: Children's Hospital for Eastern Ontario
Emergency Department
(613) 737-1100
1-800-267-1373 (from 613 area code)

Advice is available 24 hours a day, 7 days a week.

Be Prepared



Pesticides can be dangerous. They must be handled carefully to prevent injury to the user or to other people. Learn how to use them safely to prevent accidents - and always be prepared for an emergency. Here are some things you can do before an accident happens.

- Read the label before using any pesticide product. Pay special attention to the product name, the PCP Act number, the guarantee, the precautions and the first aid section. Be sure you know the signs of poisoning for the products you are using.
- Let someone else know which products are being used. Post emergency telephone numbers near the telephone.
- Keep two bottles of syrup of ipecac in the home for emergencies.
- Always have plenty of clean water close by when working with pesticides.
- Take a First Aid Course. In most communities, St. John Ambulance offers courses to help you prepare for any kind of emergency. You can also ask your doctor or the local hospital for information.

Review Questions

1. When a pesticide accident occurs and you must enter the contaminated area, what is the first thing you should do?

2. If a pesticide contacts the eyes, what should you do?

1. _____

2. _____

3. _____

3. If a pesticide spills onto your arm, you should:

- a) remove contaminated clothing
- b) wash skin and clothes thoroughly with soap and water
- c) get medical attention
- d) all of the above
- e) both a) and b) are correct

4. For chemical burns on the skin, wash with large amounts of water, then use ointment, grease or powder on the burns.

TRUE

FALSE

5. List the proper first-aid procedures when the victim has breathed in pesticide dusts, vapours or gases.

1. _____

2. _____

3. _____

4. _____

5. _____

6. You would induce vomiting if the victim had swallowed a petroleum product.

TRUE

FALSE

Protective Clothing and Equipment

Reduce Hazards and Risk

You can reduce the hazards of using pesticides by wearing protective clothing and equipment. Protective clothing and equipment can help you avoid direct contact with pesticides. The protective clothing and equipment you need to wear depends on the pesticide and the spray operation.

What to Wear

When handling any pesticide, the user should always wear:

Water Repellant Hat

Coveralls

Gloves

Boots



- a water repellant hat
- long-sleeved shirt **and** pants **or** coveralls
- gloves, unlined, elbow length
- boots, unlined, tall

Goggles



Some situations such as mixing and loading, or the use of a highly toxic product, require extra protection such as:

Respirator



- water repellant suit (rainsuit)
- apron
- goggles
- face shield
- respirator

How to Decide What is Needed

Read the Label

The section on the label called **Precautions** will help you decide what protective clothing and equipment is needed. For example:

If the label says

You should wear

Avoid contact with the skin

gloves, coveralls, boots and a water repellant hat

May cause eye irritation

goggles

Avoid breathing spray mist

respirator

The statements in the Precautions Section will be different for each pesticide. Always read the label carefully before deciding what protective clothing and equipment to wear. Never assume that the precaution statements will be the same for each pesticide.

Consider the Job

The protective clothing and equipment you need depends on the job you are doing. Each spray operation is different. Consider what is needed for each stage of the job. Consider the equipment being used and the weather conditions of the day.

The spray operation can be divided into four stages:

- Preparation
- Mixing and Loading
- Application
- After Application

Each step requires different degrees of protection.

Preparation

Before measuring, mixing or loading a pesticide, check the label to find out what protective clothing and equipment you need. Make sure that all equipment is in good condition so that it does the job. Have plenty of soap and water available in case of an accident.



Mixing and Loading

Protective clothing and equipment is very important during mixing and loading because the pesticide is in a concentrated form and is more dangerous. A spill or splash can do more damage. Always make sure your skin is covered. Wear a long sleeved shirt and pants (or coveralls), gloves, and boots. An apron will provide extra protection to the front of the body. Consider using goggles and a respirator even if the label does not suggest them.

Application

Protection during application will vary with the operation. If you will not come in contact with the spray solution, you may not need much protection. For example, you may need only a hat and coveralls to provide enough protection if you are spraying with a tractor-drawn, low pressure sprayer. However, a person spraying an orchard with an air blast sprayer will need more equipment - gloves, boots, a rainsuit with a hood, goggles, and a respirator - to give adequate protection from the spray.

Extra protection may also be needed if the machinery needs repair. Keep gloves, boots, apron and goggles available while in the field. If it is necessary to make repairs, use the extra protective clothing and equipment. A small brush conveniently located on the tractor can help unclog spray nozzles.

After Application

Even though the spraying has been completed, the spray operation is not done until after the clean up. Exposure can occur during clean up just as easily as during any other time in the spray operation. The rinse solutions can easily splash while the spray tank is being rinsed. Remember to wear a long sleeved shirt, pants, gloves, boots, and an apron during clean up.

What to Choose and How to Use It

Gloves



The hands almost always become contaminated when handling pesticides. To protect them, wear unlined, elbow length gloves that are resistant to chemicals. Suitable gloves may be made from neoprene, nitrile or PVC. The most suitable glove material depends on the type of pesticide handled.

Never wear lined gloves, or gloves made from leather or cloth. These materials absorb the pesticide and keep it in contact with the skin.

Replace gloves on a regular basis. No one knows for certain how long gloves will last when they are in contact with pesticides. Pesticides will weaken any glove material over time.

Always check gloves for leaks before using them. Fill them with water and gently force the water down to the finger tips. Gloves that leak do not give any protection. In fact, they help to increase absorption by keeping the pesticide in contact with your skin. Throw out gloves that have even small leaks.

For the best protection while wearing gloves, fold down the top of the gloves to make a cuff. The cuff will stop the pesticide from running down the glove and onto your arm when your hands are raised above the shoulder. Wear the sleeves of your coveralls or shirt over the top of the gloves. This will stop pesticides from rolling down the sleeve and into the glove.

Body Covering

To protect the body, wear a long-sleeved shirt and pants. Coveralls, worn over regular work clothes, give good protection. Keep one pair of coveralls to wear only when you are spraying pesticides. Remember to wash the coveralls separately after each use. (See Care of Protective Clothing and Equipment.)

You can also wear disposable coveralls designed for pesticide use. But make sure that the disposable coveralls you purchase are the right ones. Disposable coveralls designed to protect against dust and dirt will **not** protect you against pesticides.

Disposable coveralls specifically designed for pesticide use include the:

- **TYVEK QC[®]** coverall made by Dupont Canada Inc.
- **Saranex[®] 23P** coverall made by Dupont Canada Inc.
- **KleenGuard[®] LP** (Liquid Protection) coveralls made by Kimberly Clark

Be sure to dispose of the disposable coveralls safely. Put them in a plastic bag and dispose of them with the pesticide containers.

Some situations require additional protection. If you are working in a mist, you should wear water repellent clothing such as a rainsuit with a hood and goggles in addition to boots and gloves. Extra protection is also necessary when mixing and loading the pesticide. Wear a chemical resistant apron to protect the front of the body from splashes and spills.

Boots



Your feet can easily be contaminated if you walk through spills, enter treated areas, test spray nozzles or spray close to your body. Wear unlined boots for protection.

Do not tuck your pants into the boots. Pant legs worn outside stop pesticides from getting into the boot. If the pesticide does get inside, wash and change your boots and socks immediately.

Do not wear canvas or leather shoes and boots. These materials absorb the pesticide. Lined boots should not be worn for the same reason. The cloth lining absorbs the pesticide and cannot be washed out.

Headgear



Wear a waterproof hat to protect your head. A wide brimmed rain hat provides the best protection, especially if the spray may contact your skin. Some rainsuits have hoods attached and these provide good protection for the head and neck areas. If you cannot find a rain hat try using a hard hat. A hard hat will protect you in most spray situations and is easy to get.

Avoid wearing baseball caps or hats with cloth or leather sweat bands. These materials absorb the pesticide and provide little protection.

Goggles



Your eyes are the most sensitive part of your body - give them special protection. Some pesticides cause eye irritation and may cause severe damage if they contact the eyes. Eyes absorb pesticide quickly and completely. The absorption rate is 100%.

Protect your eyes by wearing goggles when there is any chance of getting pesticide in the eyes. Prescription eye glasses do not provide complete protection. Goggles will fit easily and comfortably over the top of normal eye glasses. Do not wear contact lenses when handling pesticides. Lenses absorb the pesticide and keep it in contact with the eyes.

Face Shields

You can protect your whole face with a full face shield. Face shields provide protection from any spills or splashes that happen during mixing and loading, when the pesticide is still concentrated. Face shields are comfortable to wear and fit easily over goggles. Some types attach to hard hats.

Respirators



A respirator is a unit that covers the mouth and nose to prevent spray droplets, small particles, and vapours from getting into the lungs. **A dust mask is not a substitute for a pesticide respirator.**

Air Purifying Respirators

There are two kinds of air purifying respirators, the half mask chemical cartridge respirator and the canister gas mask. Make sure that the cartridge or canister you use has a safety-approved sticker that says "**NIOSH**" (National Institute for Occupational Safety and Health) or "**MSHA**" (Mine Safety and Health Administration) or **BHSE** (British Health & Safety Executive).

1. **The half-mask chemical cartridge respirator** is the most common air purifying respirator. It consists of pre-filters to remove dusts, small particles and spray droplets, and cartridges containing activated charcoal to remove vapours. Special cartridges and pre-filters are needed for protection against pesticides. Make sure you ask for cartridges and pre filters that protect against organic vapours when you buy a respirator or replacement cartridges.

The pre-filters should be changed after each use. Change the cartridges whenever you can smell or taste pesticides, or at least once a year. Commercial applicators should change their cartridges more often. It is important to use the pre-filters and the cartridges together to properly protect yourself. Using one without the other is not safe.

2. **The canister gas mask** is another type of air purifying respirator. It is a full-face mask respirator that covers the eyes, mouth, and nose. It is often used in areas where there is a high concentration of pesticide vapours.

How to Fit an Air-Purifying Respirator

Air-purifying respirators come in different sizes to fit different shaped faces. When you buy a respirator, make sure it fits the person who is going to use it. Make sure that no air can leak in around the seal.

To test the fit, do a negative fit check. Cover the cartridges with your hands and breathe in. The mask will draw tightly to your face if there are no air leaks. A beard, sideburns, or even a day's growth of whiskers may prevent a proper fit.

Make sure that each time you use a respirator you have a good seal. Do a negative fit check **every** time.

Tractor Cab Cartridges

Organic Vapour Cartridges for tractor cabs are now available. Tractor cab cartridges work the same way as an air purifying respirator. The cartridges must be replaced on a regular basis to provide continued protection.

Powered Air Purifiers

In some situations you may want breathing protection that is more comfortable. One example is when spraying pesticides inside a greenhouse. Powered air purifiers, like the helmet system, provide comfortable protection. The helmet system has a motor-blower which forces air through the cartridges into the helmet. Breathing is easy because no effort is needed to draw air through the cartridges. The helmet system also protects the head and neck against exposure.

Supplied Air Respirators

Supplied air respirators supply air to a headpiece through a tube from an air tank on the wearer's back. They are designed for use when the air outside the headpiece would be dangerous to breathe. This kind of respirator would be used in an emergency such as a fire in a pesticide storage, or when applying fumigants in an enclosed area. The Self-Contained Breathing Apparatus (SCBA) is the most common type.

Care of Protective Clothing & Equipment

After the spray operation has been completed, clean all protective clothing and equipment. You can avoid contamination when removing clothing and equipment, by **keeping your gloves on**. Wash gloves before removing protective clothing and equipment.

Always remove protective clothing and equipment outdoors. If a granular pesticide was used, shake the clothing outdoors in a safe place, emptying pockets and cuffs.

Clothing that has been contaminated by spills of highly toxic or concentrated pesticide should be thrown out. Place clothing in a plastic bag and dispose of it with the empty pesticide containers.

Coveralls and other spray clothing must be washed separately from other clothes. They should be washed after each use. Place them in a plastic bag and keep them separate.

With hands still protected by gloves, wash protective equipment. It is best to wash equipment outdoors. If you do not have an outside clean-up area, keep certain buckets just for equipment clean-up. Mark them and keep them in a special place. Wash goggles, hat, boots, and any water repellant clothing in warm soapy water, rinse well and let them air-dry.

Remove the cartridges and pre-filters from the respirator. Place them in clean, sealed plastic bags, then wash the respirator in warm soapy water. Rinse well and let it air-dry. Air-drying prevents damage to the inlet and outlet valves.

Next wash the outside of the gloves with soapy water and remove them.

Place dry articles in a clean storage area until next use.

How to Wash Your Spraying Clothes

All clothing used for spraying must be washed separately from other clothing. They should be washed after each use. Remember to use gloves to handle clothing.

- Presoak clothing before washing. Use one of three methods:
 - hose off garments outdoors
 - soak in separate tub or pail
 - use prewash cycle in automatic washer
- Place clothing directly into the washing machine. Wash only a few garments at a time. Do not wash with other family clothes.
- Use hot water, the highest water level, and the longest cycle, with heavy duty detergent. Wash as you would for heavily soiled clothing.
- Wash clothing again.
- After washing, hang outside (preferably in bright sunlight) until completely dry. Do not use the clothes dryer.
- Clean the washing machine. Run the washing machine through one complete cycle using only detergent and hot water. (No clothing).

Personal Hygiene

When you are finished for the day, take a bath or shower as soon as possible. The longer a pesticide remains on your skin, the greater the risk that it will be absorbed into your body.

Always shower before eating, drinking, or smoking. Wash your hair and under your fingernails. Shower with lots of soap and water.

Always change into clean clothes.

Use clean work clothes every day. A small spill on yesterday's clothes may seem unimportant, but wearing the same clothing for several days without washing them prolongs the exposure and increases your risk.

Review Questions

1. Why should protective clothing and equipment be worn when handling pesticides?
 - a) to prevent absorption into the skin
 - b) to prevent absorption through the eyes and respiratory system
 - c) to protect the user from accidental spills and drift
 - d) to ensure safe handling of pesticide products
 - e) all of the above

2. If you are working in a mist while spraying, what additional protection should you use?

3. Why is extra protection necessary when mixing and loading pesticides?

4. Leather work boots are the best choice for foot protection when working with pesticides

TRUE**FALSE**

5. Why is it important to wear pant legs outside of boots rather than tucking them inside?

6. How often should the charcoal cartridges be changed on a half mask chemical cartridge respirator?

7. To be sure that a respirator fits properly:

- a) change the paper filter and cartridges frequently
- b) adjust the head and neck straps as tight as possible
- c) do a negative fit check to make sure there are no air leaks around the seal
- d) there is no need to worry about fit since one size fits all
- e) none of the above

8. What type of headgear should be avoided when spraying? Why?

9. Describe the correct way to wear gloves when handling pesticides.

10. Which section of the pesticide label will help you decide what protective equipment to wear while using a specific pesticide?

11. Always consider each pesticide separately. The statements in the precaution section will be very different for each product. Never assume that the precaution statements will be the same for each pesticide.

TRUE

FALSE

12. Protective clothing and equipment should be cleaned:

- a) at the end of each spray season
- b) once a week
- c) after three consecutive uses
- d) after each use
- e) whenever you spill concentrated chemical on your clothing or equipment



Transportation of Pesticides



Transportation of Dangerous Goods Act

The federal and provincial governments work together to ensure the safe transportation of pesticides.

Transportation of pesticides is regulated by two laws - the **Transportation of Dangerous Goods Act** which is administered by Transport Canada at the federal level, and the **Dangerous Goods Transportation Act** which is administered by the Ontario Ministry of Transportation at the provincial level. The Ontario Ministry of Transportation and the Ontario Provincial Police are responsible for enforcing these laws on the highways.

Penalties

The purpose of these laws is to protect public safety when dangerous goods are being transported. Anyone who does not comply with the Act or Regulations can be fined up to \$100,000 and may be jailed for 2 years. If you can prove that you took all reasonable measures to comply, then you may be found not guilty.

Requirements

The major requirements are that no one shall transport potentially hazardous quantities of dangerous goods unless:

- they are properly trained
- they follow safety procedures
- they use the required shipping documents and special product labels on the products
- they use the appropriate dangerous goods placards on the transporting vehicle.



The Regulations identify the classes of dangerous goods and the products in each class. Many pesticides are included in the list of dangerous goods as “poisonous substances”, “flammable liquids” and “products hazardous to the environment”.

Exemptions in Certain Situations

Pesticides are exempt from some federal-provincial requirements for dangerous goods. They are exempt only in the following situations:

1. Transport between the retail store and the farm or place of use

You are exempt from the Regulations when you are transporting most pesticides by road either to or from the retail outlet and your farm or the place they will be used. However, the pesticide must be in the original packaging and/or container, and each container must hold less than 454 L (100 gals). There is no maximum load limit now, but that may change in the near future.

If the pesticide you are transporting is classified as a poisonous or corrosive gas, or a substance that produces a flammable gas when mixed with water, you are not exempt. Methyl bromide is one pesticide used in Ontario that is a corrosive gas.

2. Transport from the farm to the place of use by a farm-plated vehicle

When transporting pesticides by road from the farm to the place of use you are exempt from the Regulations as long as you:

- carry less than 500 kg of pesticide (weight of the load including the container)
- the distance is less than 50 km
- display on each container the labels or markings that were on the container or other package when you bought the product.

This exemption does not apply if you are carrying a poisonous or corrosive gas, or a substance that produces a flammable gas when mixed with water.

3. Transport from the farm to the place of use by a non-farm plated vehicle

There are different requirements for vehicles that are not farm-plated. For any quantity and any distance you must:

- display on each container the labels or markings that were on the container or other package when you bought the product
- carry proper shipping documents
- make sure that the person transporting the pesticide has a training certificate. The training certificate is valid for 3 years.

You must carry the appropriate placards on your truck if:

- you are carrying any quantity of poisonous or corrosive gases, or a substance that produces a flammable gas when mixed with water
- you are carrying more than 500 kg of any product that is regulated as a Dangerous Good

Note: There are no placards for products which are classified as 9.2

4. Transport of tanks containing regulated pesticides or regulated pesticide solutions

Tanks that hold 5,000 litres or less of pesticide concentrate or pesticide solution must carry the appropriate placards before and after the pesticide application. No product identification number is required on the placard.

These are the only situations in which you do not have to follow the Regulations. In all other situations, there are no exemptions.

All Other Situations

In all other situations, you must find out how the pesticide is classified to know what is required. Consult the Regulations to find out whether some or all of the following items are needed:

- 1. Shipping documents** which indicate the shipper, receiver, technical shipping name, product classification, product identification number (P.I.N.), degree of hazard, emergency telephone numbers
- 2. A hazard warning label on every pesticide package**
- 3. Placards** with product identification numbers and symbols on the outside of vehicles (not required when carrying less than 500 kg of a product other than poisonous or corrosive gas, or a substance that produces a flammable gas when mixed with water)
- 4. Appropriate packaging of dangerous goods during transport**

5. **Training of persons involved** in the transport of dangerous goods

6. **Reporting of accidents** that represent a danger to health, life, property or the environment.

Find out what Regulations apply to your situation. Ask your farm supply outlet for information about the products you're transporting.

All companies that handle pesticides for manufacturing, formulating, or wholesale should be familiar with the details of the requirements.

Commercial pesticide applicators who transport pesticides from storage areas to application sites or to other storage sites should be familiar with the requirements for the specific pesticides they handle.

If your operations are covered by this Act, consider taking a training course to find out all you need to know.

Pesticides Act

Transportation of pesticides is also covered under the **Ontario Pesticides Act and Regulation** which have the following requirements:

1. **Warning Signs** (for more than 500 litres)



The Regulation states: "No person shall transport or cause or permit the transportation of a quantity of pesticides in excess of 500 litres by a vehicle operated on any highway or road unless the vehicle has a warning sign prominently displayed on and affixed to the outside of the vehicle warning of the presence of pesticides". (O.Reg.914, s.128)

The warning sign must say, "Chemical Storage Warning - Authorized Persons Only". This is the same sign that must be used on a pesticide storage building.



2. Separation from other commodities



The Regulation states: "No person shall transport or cause or permit the transportation of any Schedule 1, 2, 3, or 5 pesticide together with commodities that are,

- a) food or drink intended for human or animal consumption
- b) household furnishings, or
- c) toiletries, clothes, bedding or similar commodities,

by a vehicle operated on any highway or road unless the pesticide being transported is separated from such commodities in a manner sufficient to prevent their contamination or likely contamination by the pesticide". (Reg. 914, s.127)

3. Safe handling and secure transportation



The Regulation states: "No person shall transport or cause or permit the transportation of a pesticide by a vehicle operated on any highway or road unless the pesticide is secured in a manner sufficient to prevent the escape or discharge of the pesticide from the vehicle". (Reg. 914, s.126)

How to Prepare for Safe Transportation

1. **Carefully inspect each container of pesticide before you accept it for transportation.** Make sure there are no broken bags or cartons and no leaking liquid containers. Do not accept any damaged containers.
2. **Load containers carefully to prevent any movement or breakage during transit.** Take extra care with liquid pesticides. Make sure the containers are stacked securely so there is no chance they will break or spill. A spill will contaminate the other containers and the vehicle itself. If you should have a spill, do not use the other contaminated packages. Return them to the manufacturer for disposal or repackaging.



Remember that you must not leave any pesticide unsupervised in a vehicle unless:

- the vehicle is in a place not accessible to the public, or
- the pesticide is locked in an enclosed part of the vehicle (but not the cab or passenger area) (Reg. 914 s.120.1)
- the vehicle has a placard which says, "Chemical Storage Warning - Authorized Persons Only" (Reg. 914, s.120.2)

What to Do if There is a Spill

1. Any spill that may be harmful to humans or the environment **must** be reported to:

The Spills Action Centre 1-800-268-6060.

You may also contact:

- The local Ontario Ministry of Environment and Energy office
 - local police
2. If spills occur as the result of a highway accident, also notify the local police department immediately.
 3. Make sure that no one enters the vehicle without wearing the recommended protective clothing and equipment.
 4. If a closed vehicle is involved, open all doors to ensure maximum ventilation before anyone enters the vehicle to examine or remove its contents.
 5. To clean and decontaminate the vehicle, follow the steps described in the MSDS for the specific product.

Review Questions

1. If you do not comply with the Transportation of Dangerous Goods Act (TDGA), you can be fined up to \$100,000 and/or spend two years in jail.

TRUE

FALSE

2. The major requirements of transporting dangerous goods under the TDGA are:

- a) use of required shipping documents
- b) vehicle warning signs
- c) special product labels
- d) proper documentation
- e) all of the above

3. Pesticide purchasers and users may be exempt from the TDGA regulations under specific conditions.

TRUE

FALSE

4. You have purchased 400 litres of pesticide and are transporting it in your truck to your home which is 35 km away. Your truck is not licensed as a farm plated vehicle. Do you require any vehicle warning signs, shipping documents or special product labels?

5. Your spray holding tank holds a pesticide solution of 1,000 L. You would like to transport this holding tank by road to another farm 10 km away. What requirements must you meet?

6. What important pieces of information should be included on a shipping document?

1. _____
2. _____
3. _____
4. _____
5. _____

7. Ontario law states that before transporting pesticides by a vehicle operated on any highway or road, you must:

- a) carefully inspect all containers for damage
- b) secure containers to prevent breakage and movement during transport
- c) keep pesticides separate from food and feed items, furnishings and clothes
- d) all of the above
- e) both b) and c) are correct

8. If a spill occurs during transport, what should you do?

9. Spills that may be harmful to humans or the environment must be reported to:

How to Dispose of Pesticides Safely

Every time you use a pesticide, you face the problem of how to dispose of empty containers and left-over pesticide solution. Anyone who stores pesticides may have to get rid of old stock or the chemicals from a damaged container. Never be careless when disposing of empty containers, left-over solutions, or surplus pesticide concentrates. You can prevent environmental damage if you take the time to follow proper disposal procedures.

Empty Pesticide Containers

Avoid Disposal Problems

You may not have a problem disposing of pesticide containers in your local landfill. However, in some municipalities, landfill operators are restricting or refusing pesticide containers.

To avoid problems with container disposal, you can:

- **Buy the required product in a dry formulation.** Paper packaging can be burned on your farm (see specific guidelines under disposal).
- **Buy in bulk.** A number of herbicides (and other products) are available in mini-bulk, or shuttle containers. These containers hold from 50 to 400 litres of product and can be returned as a sealed unit. Although you have to pay more at one time, these containers completely eliminate disposal problems.
- **Look for products that come in soluble packaging.** The package is made of polyvinyl alcohol that dissolves when it comes into contact with water. There is no container left for disposal.

Rinse Containers

What do you do with the empty pesticide containers after you have finished your pesticide application?

These pesticide containers are not really “empty”. They still hold about 1 % of the original amount of pesticide. Although this figure sounds low, it is still a hazard to humans, animals, and the environment. To reduce the hazard, rinse each container as the spray tank is filling. Use either the manual triple rinse technique, or a specially designed device for rinsing containers.

Triple Rinse

To Triple Rinse

1. Fill the empty container **at least** 10% full of the diluting material (usually water).
2. Cap, then shake or roll the container so that the inside surfaces of the container are well rinsed.
3. Empty rinsings into the spray tank.
4. Repeat steps 1 - 3 twice more.

Remember to check the container after you have finished rinsing. Make sure that no pesticide has been left behind as a cake or paste on the bottom of the container.

Rinsing Devices

Rinsing devices use pressurized water to clean out the container. They are just as effective as triple rinsing but take less time. Follow the manufacturer's instructions.

How to Dispose of Containers Safely

Empty containers should never be re-used on the farm. They may be handy, but there is still some risk even if the containers are triple rinsed. Never give empty, rinsed containers to anyone, especially not children. Dispose of them promptly.

The Pesticides Act regulates how pesticide containers are to be disposed of in Ontario.

A container that has been used to hold a Schedule 1, 2 or 5 pesticide shall be disposed of,



a) by puncturing or breaking and burying the container in such a manner that it is covered by at least 50 centimetres of soil and is not near any watercourse or water table; or



b) where the container is constructed of paper or cardboard, by burning, in circumstances that persons and animals are kept out of any resultant smoke and any resultant smoke is directed away from buildings, highways, roads, or outdoor areas frequented by the public. (Reg. 914, s.27)

For Metal, Plastic, or Glass Containers

Once containers are properly rinsed, they should be punctured (plastic), crushed (metal), or broken (glass), to make it impossible to use them again.

It is often more convenient to store empty, rinsed containers until you have collected enough to make a trip to the collection/re-cycling depot or the landfill site. If you store containers, keep them in a safe place, such as the storage area, until you can dispose of them at the local landfill site.

The **Ontario Pesticide Container Re-cycling Program** has been available to growers and commercial applicators in recent years. Through this program, **clean, triple rinsed, plastic/metal pesticide containers** (up to 23 litres in size) can be returned to collection depots located throughout the province.

A re-cycling depot has been established by Future Farm Supply in Aylmer, to collect empty 45 gallon drums that contained sucker oil and fumigants used in tobacco and fruit production.

If you are a Retail Class 1 or 2 pesticide vendor and wish to participate in the Ontario Pesticide Container Recycling Program as a **pesticide container depot**, contact the Ministry of Environment and Energy.



The employees at a pesticide container depot must:

- inspect every container to ensure that only clean, emptied, triple-rinsed or pressure jet rinsed pesticide containers, federally classified as agricultural or commercial are accepted
- remove and collect container lids and labels for disposal
- refuse plastic containers greater than 23 litres in size and metal containers greater than 20 litres in size
- wear the proper protective clothing and equipment
- store containers in a secure storage area.

To ensure safety, the following should be available to pesticide container depot employees:

- cholinesterase evaluation
- wash water and soap
- showers
- laundry facilities
- first-aid equipment and eye wash station
- radio or telephone for contacting emergency personnel
- a set of MSDSs and labels of the products collected at the site.

For Paper and Cardboard Containers

Paper or cardboard containers are often rigid enough to withstand rinsing. If it is possible, triple rinse these containers as you fill the tank. Then burn the containers in an isolated area.

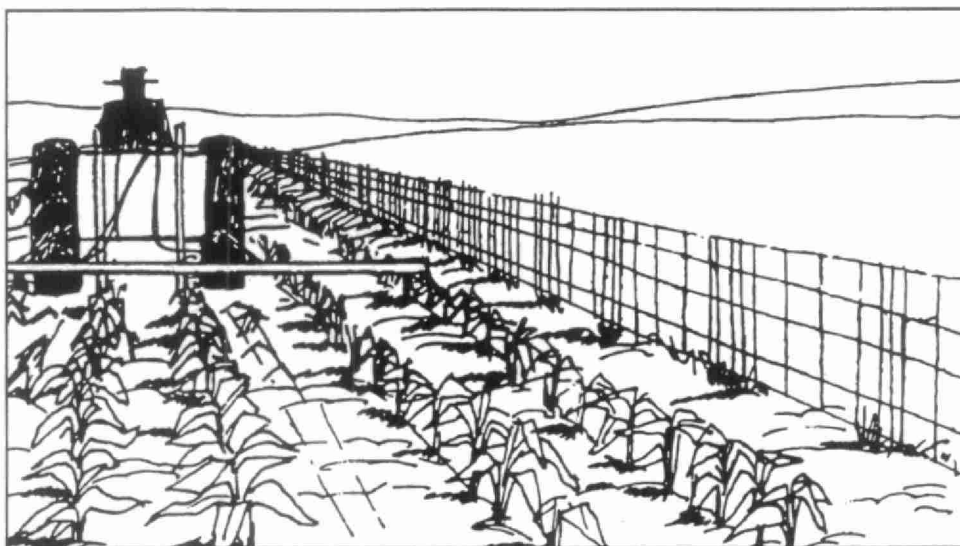
Be very careful around the smoke. It may contain toxic fumes from the burning pesticide. Be certain that there is no chance that a person or animal may breathe in this smoke. Make sure that the smoke does not drift towards buildings, roads, or any public outdoor areas.

These containers can also be taken to a local landfill site, or buried in the same way as metal, plastic, or glass containers. If you can't dispose of them immediately, make sure containers are kept in a secure place such as the pesticide storage area.

Rinsing and disposal of containers

Pesticide Container	Formulation	Rinsing Technique	Method of Disposal
Plastic	SN,EC,Fl,Li,Su	Jet or triple rinse	Re-cycle if possible. Puncture and bury
Metal	SN,EC,Fl,Li,Su	Jet or triple rinse	Re-cycle if possible Puncture and bury
Paper bag	GR,SP,SP	Shake empty, rinse if possible	Burn or bury
Plastic bag	GR,SP,SP	Single rinse	Bury
Glass bottle	SN,EC	Triple rinse	Break and bury
Drum (200 L)	SN,EC,Fl,Li,Su	Triple rinse	Recycle if possible; crush and bury

EC-emulsifiable concentrate, Fl-flowable, GR-granular, Li-liquid, SN-solution, SP-soluble powder, Su-suspension, WP-wettable powder



Surplus Spray Mix

Try to avoid having any pesticide left over after you have finished spraying. Make sure that you calculate carefully how much spray mix you need before you begin. Excess spray mix is a waste of money as well as a disposal problem.

Avoid Surplus Spray Mix

- Check all the information on the label before the spray operation.
- Make sure you have identified the pest problem properly and selected the right pesticide. This will prevent having to get rid of a tank-load of the wrong pesticide.
- Check the pesticide rate, the size of the area that needs the pesticide application, and the output of your sprayer.
- Calculate the amount of spray mix carefully. See "Applying the Right Amount of Pesticide" for a review of the steps involved.
- Make sure that the pesticide you mix can be applied. Some pesticides require a set amount of time before a rainfall to work well. Read the product label and watch the weather.

Disposal of Surplus Spray Mix

NEVER re-spray the treated field with excess spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you can't find another field to spray, then dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. This diluted solution can be safely applied to the treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest, or surplus spray mix disposal.

Surplus Pesticide in Storage

Avoid Surplus Pesticides



Check the storage area for surplus pesticides. Try to store as few pesticides as possible. This will reduce the chance of an accident occurring.

- Reduce surplus pesticides by buying wisely. Buy only what you need for each season. Make sure you buy the right pesticide to control the pest problem.
- Keep an accurate inventory of all pesticides in storage. Remember to use old inventory before purchasing more pesticides.
- Mark the purchase date on each pesticide container. Most pesticides retain their effectiveness for two or more years if stored properly - meaning cool, not freezing temperatures, and dry storage conditions. If you are not certain whether old pesticide supplies will be effective, use the following guidelines.

Guidelines for disposing of old pesticides

Formulation	Discard material if:
Dust	material has lots of lumps
Emulsifiable and spray concentrate	<ul style="list-style-type: none"> • the solution does not turn milky when mixed with water • the mixture separates • a sludge forms
Flowables	has a layer of caked material on container bottom (may or may not go back into suspension with agitation)
Granulars	<ul style="list-style-type: none"> • material is lumpy or caked • does not run freely
Solutions	active ingredient crystallized out and settled on bottom (may go back into solution with agitation - refer to product's label)
Wettable powders	material is lumpy and powder will not mix with water

Disposal of Surplus Pesticide

If you have pesticides that you don't need or can't use, be sure to dispose of them safely.

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original container.
- If you cannot find any way to use the product as shown on the label, contact your local Ontario Ministry of Environment and Energy office. They will be able to give advice on how to properly dispose of the pesticide.
- Watch your local paper for "Municipal Waste Days" or contact your municipality. If your municipality has no waste days, encourage them to sponsor such an event. On these days, you can turn over surplus pesticide concentrates for disposal.

Review Questions

1. An empty pesticide container still holds approximately 1 % of the original amount of pesticide.

TRUE

FALSE

2. Explain the steps involved in triple rinsing.

1. _____
2. _____
3. _____
4. _____

3. Rinsing devices that use pressurized water are not as effective as triple rinsing. -

TRUE

FALSE

4. In Ontario, the _____ regulates how to dispose of pesticide containers.

5. It is safe to re-use empty pesticide containers once they have been triple rinsed.

TRUE

FALSE

6. When burning paper or cardboard pesticide containers, avoid the fire's smoke. It may contain toxic fumes from the burning pesticide.

TRUE

FALSE

7. How would you, as a pesticide user, try to avoid having surplus tank mix? State 2 suggestions:

1. _____
2. _____

8. To dispose of excess tank solution, re-spray the treated field. A double dose will only help to control the pest problem.

TRUE

FALSE

9. A wettable powder that is lumpy and will not mix with water should be discarded.

TRUE

FALSE

10. How do you properly dispose of surplus pesticides in storage? Give three suggestions.

1. _____
2. _____
3. _____

How to Store Pesticides Safely

To operate your business safely and efficiently, you must store pesticides properly. By following all the regulations for storing pesticides, you will help reduce the hazard to your employees, your neighbours, and the surrounding environment.

Pesticide Storage Regulations

It is illegal to store pesticides under unsafe conditions. The Pesticides Act gives safe storage requirements for storage facilities. (Reg. 914, s. 119 to 123). It is also necessary to follow the Ontario Building Code.

Under the Pesticides Act, **all** pesticides must be stored so that:

- they do not contaminate food or drink used for humans or animals
- they do not impair the health or safety of any person
- they do not contaminate the natural environment
- they are in an area which is kept clean and orderly
- there is a chemical warning sign displayed
- there is a list of emergency telephone numbers posted near the storage area

The more toxic pesticides have additional storage requirements.

This chart provides a quick check list of the storage requirements under the "Pesticides Act". The following pages discuss each regulation in more detail.

Schedule	Regulation	Wholesale	Retail 1,2	Retail 3	Operator, Applicator	Agriculturist	Person
1,2,3,4,5,6	No Contact with Food or Drink	✓	✓	✓	✓	✓	✓
	Unsupervised Vehicle, Unaccessible or Locked	✓	✓	✓	✓	✓	✓
	Unsupervised Vehicle, Warning Sign	✓	✓	✓	✓	✓	N/A
	Not Impair Health/Safety	✓	✓	✓	✓	✓	N/A
	Clean & Orderly Manner	✓	✓	✓	✓	✓	N/A
	Warning Signs Posted	✓	✓	✓	✓	✓	N/A
	Emergency Numbers Posted	✓	✓	✓	✓	✓	N/A
1,2,5	Ventilated to Outside	✓	✓	✓	✓	✓	✓
	Limited Access (Locked)	✓	✓	✓	✓	✓	✓
	Outdoor Storage - Security & Sign	✓	✓	✓	✓	✓	✓
	Contacted Fire Dept	✓	✓	N/A	✓	N/A	N/A
	No Floor Drain	✓	✓	✓	✓	✓	N/A
	Safety Equipment Available	✓	✓	✓	✓	✓	N/A
1,5	Area Exclusive for Pesticides	✓	✓	✓	✓	✓	N/A
	Proper Fire Resistance Rating	✓	N/A	N/A	N/A	N/A	N/A

N/A NOT APPLICABLE

Storage Site

The pesticide storage should be isolated from children and livestock, and from any area where human food or animal feed is stored. Avoid sites where there is any chance that runoff or drainage water from the pesticide storage area may enter surface or ground water. When choosing a storage site, avoid areas that flood.

Evaluate the location of your pesticide storage. If it is less than 50 metres from highly populated areas, you may need to move the location. Ensure that contaminated water or pesticide does not run into populated areas. Talk to local authorities (eg., municipality, region) to find out.

Make sure emergency personnel can enter the area after business hours. Keep entrances and emergency equipment clear and easy to get at.

Building a new warehouse or storage facility

Do not put a new storage site closer than 50 metres from residential properties, high occupancy buildings and food or feed processing facilities.

The building should be a freestanding structure with a fire resistance rating of at least one hour. The building must comply with the Ontario Building Code, 1990, as well as your municipal by-laws. You will need a building permit for a pesticide storage. Check with your municipality for other requirements.

Make sure that the building is well above the water table and away from any water source (well, ditch, creek). When planning your storage, be sure to plan how you will contain any water contaminated by a spill, or used in fighting a fire. Make sure contaminated water will not enter storm sewers or other water ways.

Storage Building

The area or building used for pesticide storage should have a floor that does not allow seepage - a concrete or asphalt floor is best. Drains are not allowed unless they lead into a separate holding tank which can be pumped out. The storage must be ventilated to the outside with windows or a fan system.

Keep all unauthorized persons from entering the storage area. Make certain that the area can be securely locked. Make sure that warning signs with the words, "Chemical Storage Area - Authorized Persons Only", are posted on all storage doors.

Emergency equipment and protective clothing must be available close to the storage area to be easily accessible in an emergency. Do not store protective clothing and equipment in the storage area because it may become contaminated.

Emergency telephone numbers must be posted nearby for quick reference:

- fire department
- physician
- police
- hospital
- ambulance
- Spills Action Centre
- local Ministry of the Environment Office
- Poison Information Centre

A wholesale or limited wholesale vendor who sells Schedules 1 and 5 pesticides must have a storage area with a fire resistant rating of one hour for the room and a fire resistance rating of 45 minutes for doors and door frames. (Reg. 914, s. 123(2))

Temporary Storage

A temporary storage can be set up outside for large bulk containers that are weather-proof. The area must be fenced, signed and secure enough to deny access to unauthorized persons. They may also be stored on a transport trailer. Make sure that the site is not a hazard to wells or waterways in case of a spill.

Storage During Transportation

The Pesticides Act also regulates storage during transportation. The pesticide must be locked in the trunk of the vehicle, not the cab or passenger area. A "Chemical Storage Warning" sign must be placed on an unattended, parked vehicle that contains pesticides. If the pesticide cannot be locked up, an authorized person must stay with the vehicle. (Reg. 914. s. 120)

When transporting pesticides to the place of use, the vehicle should be locked and not accessible to the public.

Storage Tips

Although these storage tips are not required by law, they are important points to consider. How pesticides are stored is as important as where they are stored.

1. Store pesticides in a dry area. Moisture will cause containers to rust and bags to split, causing spills and loss of pesticides. Pesticide labels may deteriorate with moisture and be impossible to read - a loss of essential information.
2. Some pesticides require protection from freezing if stored over the winter. If you are holding these pesticides over until the next season you will have to winterize the storage area. Read the pesticide label - it will tell you any special temperature requirements for storage.
3. Volatile chemicals should be stored separate from other products. The vapours they give off could contaminate other products. When the contaminated pesticide is used to control a pest problem, non-target plants or animals may be affected. If possible, keep herbicides and other highly volatile products in a tightly sealed container or in a separate storage area.

4. The storage area should be separate from the employee lunch room, wash rooms and work areas. Areas used by employees should be ventilated to control fumes and odours.
5. You must meet all building, fire and electrical codes. These codes can change, so check them regularly to make sure your building meets all requirements. If heating is required, fire heaters are not recommended.
6. You should be able to contain contaminated water or spills within the storage so that the environment is not harmed. A retaining curb around the perimeter of the floor, or a holding tank or lagoon are effective ways to contain liquids.
7. Pesticides should be stored away from high traffic areas and loading doors. The pesticides you use the most should be the easiest to get to. Make sure that stored materials do not block fire extinguishers, alarm boxes, sprinkler system controls, electrical switch boxes, emergency lighting, first aid equipment, exits, safety showers or eyewash stations. There must be clear access to emergency equipment at all times.
8. Materials stored in tiers should be stacked, strapped, blocked or interlocked. Don't stack the material too high - follow the supplier's suggested height limits. Make sure that tiers are stable and secured to prevent sliding or collapse. Keep a one metre clearance from heaters and sprinkler heads.
9. Where possible, store pesticide containers off the floor to prevent damage from spills or water. Store containers in rows, or in stacks with aisles for easy access. Keep aisles clear. Make sure that product labels are visible.
10. Pesticides that contain oils or organic solvents are likely to be flammable or combustible. Certain dry formulations may also present fire and explosion hazards. Check the product label for information on the hazards and the correct precautions.

11. Flammable and combustible materials should be stored in a separate section of the warehouse. This area must be well-ventilated and free from any possible source of flame. Follow all federal and provincial regulations on storage for flammable and combustible materials. Security will be best if there are no windows in the warehouse, but if there are windows, make sure they are secured.

Good Housekeeping

Pesticide containers may become damaged during warehousing and handling. If the product spills, you will be faced with environmental and health risks, costly inventory write-offs, and difficult disposal problems. To increase safety in the workplace and maintain quality products, try these suggestions:

1. Keep floors, stairways and loading areas clean and clear to reduce the hazard of slipping or tripping.
2. Make sure there is good lighting throughout the storage area.
3. Keep machines, equipment and working surfaces clean and in good condition.
4. Keep enough space between rows to permit visual inspection of containers for corrosion and leaks.
5. Keep containers away from water leaks and/or floor seepage. Wet bags, boxes and metal containers deteriorate rapidly.
6. Do not stack any equipment or other products on or against pesticide containers.
7. Do not have open flames in a storage. (e.g. - a lit match, blow torch, burning garbage, or cigarette)
8. Remove hazardous materials such as oily rags and broken pallets.

9. Reduce the chance of tearing, puncturing or breaking containers by using proper equipment. Make sure that all employees know how to handle the equipment and how to stack containers safely. Give special attention to operating forklifts carefully.
10. Keep all pesticides in their original, labelled container. Unlabelled pesticides are dangerous and illegal. Never store pesticides in any container that was previously used to hold a food or beverage. Pesticides in old food/ beverage containers are often mistaken as a food/beverage and may be swallowed accidentally especially by small children.
11. Make routine inspections of containers. Look for rust, leaks, loose caps or bungs. If you find a damaged container, remove the pesticide from its original container. Place the pesticide in a container that is similar to the original (e.g. - plastic replaced with plastic). Close the new container tightly and label it with the necessary information. Sometimes it is possible to take the label from the damaged container and attach it to the new container. Control leaks and decontaminate the area immediately.
12. If you must repackage a pesticide, label the new container with the pesticide's trade name or common name and the concentration of each active ingredient in the formulation. This is a requirement of the Pesticides Act. (Reg. 914, s. 26)
13. Never refuse a shipment of damaged goods. The receiver should deal with the damaged pesticide. Read the Material Safety Data Sheet (MSDS) for information on how to handle the pesticide safely. You can call the supplier or CANUTEC (Canadian Transport Emergency Centre 613-996-6666 - call collect) for information on cleanup and disposal. Follow proper procedures for cleanup and disposal of the product. If there is a lot of damage get help from the fire department.
14. Keep an accurate inventory of the pesticides in the storage building. This will help you estimate the amount of a pesticide in case there is an accident or spill. Keep this information away from the storage area but within easy reach in case of an emergency.

15. For quick reference, MSDS, technical bulletins, product labels and other information should be kept up to date and readily available to all employees. There should be a MSDS for each product. Keep these records away from the storage but readily available in case of an emergency.

Guidelines for Bulk Storage of Pesticides

If you have a bulk pesticide system, or are thinking of installing one, follow these safety guidelines:

1. Set up a regular program of maintenance and inspection for all pumps, valves etc. Replace damaged or worn parts immediately. Keep a supply of spare parts on hand so that you can make repairs without losing a lot of the product.
2. Make sure that all bulk storage tanks have dikes or retaining walls to collect the pesticide in case of a spill. If you can keep the product on the property, you can prevent contamination of surrounding waterways, sewers or wells. You may also be able to recover some of the product, or dispose of it safely.

Get professional advice when building a retaining system. Dikes or retaining walls should be constructed from concrete or earth, and lined with a material that will prevent the chemical from seeping into ground water. They must be large enough to hold the total amount of liquid plus 10 percent more, if you are using one tank. If you have more than one tank, the retaining system must be able to hold as much as the largest tank plus 10 percent of the total capacity of all the other tanks.

3. Make sure that all liquid transfer systems are designed to prevent overflow while filling operations are under way.
4. Be sure to include a system to contain and dispose of tank washings, pump washings, etc.

Handling Mini-Bulk

Mini-bulk containers are now available to the customer. These containers are popular because they can be refilled and may reduce exposure to the pesticide. Because of their size, however, a small leak could cause a major spill. Make sure that you handle them safely.

1. Check all mini-bulk tanks for leaks.
2. Use proper filling procedures:
 - pump the correct pesticide into the correct tank
 - check all connections to avoid leaks or spills
 - contain any pesticide that runs out
3. Strap down the tanks securely for transport.
4. Make sure the containers are properly labelled before the customer takes them home.

Crop Protection Institute Standards

The Crop Protection Institute (CPI) has adopted new standards for the storage of pesticides used in agriculture and industry. The Institute is asking all members to upgrade their warehouses to meet their standards. To get a copy of the "Crop Protection Institute Warehousing Standards" write or telephone:

Crop Protection Institute
21 Four Seasons Place
ETOBICOKE, Ontario
M9B 6J8
Tel: (416)622-9771
Fax: (416)622-6764

Even if you are not a member of the Institute, you can check your warehouse against their standards. There is a handy checklist at the back of the CPI manual.

Review Questions

1. What type of vendor requires a storage building with fire resistance ratings?
2. If you, as a vendor, stop and leave your vehicle when transporting pesticides, what must you do?
3. You find that you must put some pesticide into another container. How should you properly label the new container?
4. To properly store a Schedule 3 pesticide, what must you do?

Pesticides and the Environment



Over the past 20 years we have all become more aware of the importance of the natural environment. To protect the environment, we must prevent damage from careless use of pesticides.

Because farmers own a large portion of Ontario's private lands, they have a greater responsibility to protect the environment around the farm and around their community.

If you use pesticides, find out how these chemicals affect the environment. This information is most readily available on the pesticide label.

Make sure that you use pesticides safely and **only when necessary**. Remember that a healthy environment is everyone's responsibility.

This section explains:

- the physical and chemical properties of pesticides which make them harmful to the environment
- some of the problems pesticides may cause
- how to use pesticides so that they cause the least amount of damage to the environment.

Pesticide Fate

The physical and chemical properties of pesticides influence their potential to harm the environment. The most important properties are:

- their ability to breakdown in the environment (**Degradation**)
- how long they last in the environment (**Persistence**)
- their ability to accumulate in body tissues (**Bio-accumulation**)
- their ability to change into a vapour when exposed to air (**Volatility**)
- their ability to bind with soil particles (**Adsorption**).

These properties, combined with natural processes such as runoff, leaching, drift, and erosion, determine what happens to a pesticide, and where it ends up, after it is released into the environment.

Physical and Chemical Properties of Pesticides

Degradation

Most pesticides breakdown in the environment. This breakdown is known as **degradation**. The rate of pesticide breakdown is affected by many environmental factors including temperature, moisture and pH. The breakdown occurs through:

- microbial degradation
- chemical degradation
- photodegradation

Microbial degradation is the most common type of pesticide breakdown. Soil microorganisms use the pesticide as a food source. They break the pesticide into basic compounds such as water and carbon dioxide.

Chemical degradation is simply a chemical reaction that occurs between the pesticide and other chemicals in the environment, such as water. This type of degradation generally splits the pesticide into less hazardous compounds.

Photodegradation is the breakdown of pesticides by sunlight. Pesticides react differently when exposed to sunlight. Some pesticides breakdown very rapidly and therefore must be incorporated into the soil shortly after application.

The speed that a pesticide breaks down in the environment is measured by its **half-life**. That is the time it takes for one half of the pesticide to breakdown in the environment. For example, 2,4-D has a half-life in soil of about two to three weeks. If it were applied at the rate of 1 L/ha, two to three weeks later there would only be 0.5 L/ha left in the environment. The rate of breakdown varies with environmental conditions.

Persistence

A pesticide that remains in the environment without change for a long period of time is **persistent**. This property is good for long term pest control, but it also means the pesticide can cause environmental damage over a long period of time. Persistent pesticides are more likely to move from the application site into local water supplies. Water contaminated with pesticide is harmful to humans, fish, and wildlife.

Atrazine is an example of a pesticide that is very persistent. It has been found in surface and ground water all over southern Ontario. Many farm wells, particularly in corn growing areas, contain residues of atrazine.

If information about the persistence of a pesticide is available, choose one that provides the control you need with the least persistence.

Bio-Accumulation

Bio-accumulation is the ability of some pesticides to build up in the body tissue of animals. The higher the concentration of pesticide, the more harmful it is to the person or animal. Pesticide build-up can cause death or long-term damage.

Pesticides can also build up in the food chain - a process known as **bio-magnification**. If we consider the food chain, we can see how a persistent pesticide can accumulate to a hazardous level, even though it is applied according to label directions.

Suppose a pesticide is applied to a field at the recommended rate to control a certain kind of insect. During the application, the insecticide is picked up by other insects. A frog may eat hundreds of these insects within a few days. This will concentrate the pesticide within the tissues of its body. If a snake eats a number of contaminated frogs, the initial insecticide dose may be concentrated in the snake's body several thousand times. If a hawk eats that snake and a number of others, the concentrated pesticide may affect the hawk's ability to reproduce.

Bio-magnification or accumulation of persistent pesticides in food chains was one of the reasons for banning chlorinated hydrocarbon pesticides such as DDT.

Accumulation also occurs in aquatic systems. Fish are affected when their water habitats or food sources are contaminated. The extent of damage to the fish depends not only on the properties of the pesticide, but also on the species of fish, its age, size, and its position in the food chain.

Fish that have larger amounts of body fat will accumulate more organic pesticides if they are exposed. Younger and smaller fish usually have lower levels of contaminants than older and larger fish, since the younger fish have had less exposure. The position of a species in the food chain will also affect the level of contamination. Fish species that feed on smaller fish will have higher levels of organic contaminants because of bio-accumulation.

Volatility/Volatilization

Volatilization is the process of a liquid or solid changing into a vapour when it is exposed to air. Some pesticides change more quickly into vapour than others - they have a high volatility. Volatilization of pesticides increases when the temperature is high and/or when small spray droplets are used. The movement of pesticide vapours is called **vapour drift**.

Pesticides can be added to the air through vapour drift, during aerial spraying or when soil is eroded by the wind. Pesticides in the air may return to earth in rain or snow, far away from where the pesticide was used. This is the reason why pesticide residues have been found in the snow and the tissues of animals in the Arctic and Antarctic regions.

To reduce volatilization, avoid spraying when temperatures are high, and use low volatility formulations. For instance, 2,4-D is available in amine or ester formulations. The ester formulations are volatile, so only the amines should be used near susceptible crops.

Adsorption

Adsorption is the binding of pesticides to soil particles. The amount of adsorption in the soil depends on:

- the type of soil
- the conditions
- characteristics of the pesticide

Soils high in organic matter or clay are the most adsorptive. A pesticide that is adsorbed by the soil is less likely to turn into vapour. However, it will move with the soil if it is eroded and may contaminate water bodies. If contaminated soil particles are blown by the wind, the pesticide may be spread over a great distance.

Natural Processes that Affect Pesticide Fate

Drift

Pesticides may move from the target site because of vapour drift or spray drift. Vapour drift is the movement of pesticide vapours that was described above. Spray drift occurs when the wind is strong enough to pick up and carry fine spray droplets. Fine spray droplets are produced by high pressure spraying.

To reduce spray drift, decrease spray pressure and avoid spraying when winds are more than 10 km/hr. Spray drift is a major concern when pesticides are applied from the air.

Surface Runoff

The runoff of surface water moves pesticides from treated land into streams, rivers, ponds, and wells. If heavy rains occur shortly after the application and residues are still on the surface of soil and plants, large quantities of pesticides can be washed into ditches, streams, and ponds. **The greatest loss from runoff usually occurs when rain falls within 24 hours of application.**

However, pesticides which persist in the soil can be carried in runoff water even many months after application. A persistent pesticide, such as atrazine, may also be moved into water sources the following spring by melting snow and spring rains. Pesticides can be found in surface water throughout the year, but the worst months for pesticides entering surface water are January to April. About half the amount of persistent pesticides that move into surface water enters during these months.

Runoff from pesticide-treated areas can pollute streams, ponds, and lakes, and contaminate groundwater. It can damage plants and animals in areas that were not treated.

Pesticide runoff can be reduced by:

- using adjuvants to make the pesticide adhere to plant surfaces
- incorporating the pesticide into the soil as soon as possible
- implementing no-tillage and minimum tillage practices
- observing the weather conditions. If rain is expected, delay your application of pesticide.

Leaching

Leaching occurs when pesticides dissolved in water move down through the soil. When combined with soil moisture, a pesticide may leach into the groundwater or flow through the tile drainage system into surface waters.

Pesticide leaching is a major cause of groundwater contamination. Once groundwater is contaminated, it is difficult to clean up. To reduce groundwater contamination, learn how to apply pesticide properly and consider using alternatives to pesticides.

Remember

Pesticides are more likely to leach through coarse textured sandy soils than through clay soils.

Pesticides which adsorb or bind to soil particles are less likely to leach. Pesticides which persist in the soil and are not adsorbed are more likely to reach a water source through leaching.

Environmental Hazards

Water Damage

A body of water can be easily contaminated if pesticide is not applied correctly. Once the water is contaminated, it cannot be used by people, animals, or plants.

The Ontario government monitors the level of pesticide residue in streams, rivers, farm ponds, and wells. These surveys show some evidence of pesticides in surface and ground water in southern Ontario. The level of pesticide residue is usually below the acceptable limits, but some tests show contamination of the water.

You can prevent contamination of water sources by following these steps:

- **Do not spray right to the edge of a water body. Leave an area of natural vegetation that is not sprayed. This is called a buffer zone.**

- Apply all pesticides according to label recommendations. If possible, reduce the amount of pesticide you use.
- Carefully measure the amount of pesticide that is loaded into the spray tank.
- Make sure that sprayers are calibrated correctly and all equipment is properly maintained.
- Spray only when weather conditions are suitable.



- Never use water from a well, lake, river, or other surface source without having an anti-backflow device on your equipment. Reg 914, s.25(1) of the Pesticides Act requires you to have an anti-backflow device.



- Never wash spray equipment close to a well, lake, river, or other surface water. Reg 914, s.25(2) of the Pesticides Act makes this illegal.

Soil Damage

Many pesticides break down or degrade in the soil, but some persist (last) for long periods of time. Some examples of herbicides which persist in Ontario soils include atrazine, simazine, metolachlor, and terbacil. Because these pesticides are persistent, there is a greater chance that they will contaminate water sources through leaching or surface runoff. They may also damage sensitive or susceptible crops planted the following season.

Soil can also be contaminated by:

- using more pesticide than is recommended
- spills which occur during mixing and loading
- tank overflows
- improper disposal of containers or surplus spray mixtures

Spills on sand or sandy loam soils can lead to serious contamination of groundwater through leaching. Spills on clay soils remain on the soil surface longer and are more likely to spread to other areas because of surface runoff.

Damage to Insects and Wildlife

We know that pesticides can be harmful to people. But some may be even more harmful to beneficial insects, fish, birds, wildlife, and domestic animals. Even a small amount of pesticide in the natural environment can be extremely dangerous. Always follow the label directions and precautions when using pesticides around wildlife areas.

Protecting the Environment

The law says that you must immediately report any spill or other accident with a pesticide to the Ministry of Environment and Energy. Immediate reporting allows the Ministry to act quickly to assess the damage and control it.

Beneficial Insects

Beneficial insects, such as the Praying Mantis, Lady Bird Beetle (Ladybug) and Assassin Bug, prey on pests. These insects help to control pest populations naturally.

Widespread use of pesticides can kill beneficial insects as well as the target pests. If the number of beneficial insects is decreased, the natural balance is upset. There are fewer natural enemies to keep the pests under control. Those that survive the spraying may multiply quickly because of the lack of natural predators.

Bees are important beneficial insects because they pollinate tree fruits, small fruits, legumes, and other vegetables. Bees can be poisoned by pesticides through direct exposure during spray operations.

Also, bees can be indirectly poisoned if the pollen they collect and store in the hive is contaminated with pesticide dust. The extent of damage to bee populations will be influenced by the kind of exposure, the toxicity of the pesticide, and its persistence.

You will know that bees are being affected by pesticide if you see:

- large numbers of dead bees in front of hives
- aggressive bees
- slow moving bees (possible carbamate poisoning)
- sudden decrease in the number of bees

How you can protect bees from pesticide poisoning:

- **Do not apply insecticides while tree fruits and other crops are in bloom.** The “**Bees Act**” makes it an offence to do so in Ontario. You may be fined from \$1,000 to \$5,000.
- If you are a beekeeper, register with the provincial apiarist.
- Contact the provincial apiarist before you do any aerial spraying. You can get the number from the local OMAFRA office. The provincial apiarist will give you a list of beekeepers in your area.
- Use pesticides that are less hazardous to bees whenever possible.
- Make pesticide applications early in the morning or in the evening when bees are not active.

Fish

Some pesticides are highly toxic to fish. A high concentration of a pesticide in water may kill the fish or the organisms they eat. Lower concentrations may affect the fish's ability to reproduce or cause other long term damage. Pesticides can also accumulate in fish and make the fish unsuitable for eating.

The only way to prevent the contamination of fish is to prevent the direct or indirect contamination of water sources. Leave an unsprayed buffer zone of natural vegetation around water bodies and reduce the amount of pesticide you use.

Birds, Wildlife & Domestic Animals

Birds, wildlife, and even domestic animals can be poisoned by direct exposure to pesticides during spray operations. Birds are often poisoned by eating granular insecticides or treated seed that has been discarded or poorly stored.

Indirect exposure is usually the result of food or water supplies being contaminated. Indirect exposure is just as dangerous as direct exposure. It can cause death or impair the animal's health and ability to reproduce.

General Procedures for Applying Pesticides Safely

If you must use a pesticide, the following procedures can help to protect the environment:

1. Read the label and follow all instructions carefully. Never exceed the application rates recommended on the label.
2. Never spray when weather conditions are unsuitable.
3. Calibrate the sprayer to ensure the correct spray volume is being delivered.
4. Rotate crops to reduce high populations of pests that thrive on a specific crop.
5. Select the least toxic and least persistent pesticide that will give the desired result.
6. Do not spray right to the edge of a water body. Leave a buffer zone of natural vegetation that is large enough to prevent contamination.
7. Handle and mix pesticides with care at all times. Never carry or mix pesticides near a water body.
8. Use pesticides only when necessary. Consider the use of non-chemical alternatives (such as - conservation tillage, crop rotations and Integrated Pest Management practices) to reduce the amount of pesticide you need.

Review Questions

1. List 5 properties of pesticides which affect their fate in the environment.

1. _____
2. _____
3. _____
4. _____
5. _____

2. Name the term given to the process of pesticides building up in the body tissue of animals.

3. A pesticide that remains in the environment without change for a long period of time is:

4. How can a persistent pesticide damage the environment?

5. Name three ways a pesticide can move in the environment.

1. _____
2. _____
3. _____

6. Give three examples of pesticides known to persist in soil

1. _____
2. _____
3. _____

7. Pesticides are never toxic to aquatic life.

TRUE

FALSE

8. _____ insects include species which prey on and attack pests. These insects aid in the natural control of the pest population.

9. If a pesticide application is necessary, there are some general things to do to protect the environment. List them.



Food Safety

The use of pesticides and food safety is a concern to all consumers.

There are three ways in which our food is protected from pesticide contamination:

1. government regulations that control how pesticides are used
2. government programs to check food regularly (food monitoring)
3. farmers' agricultural practices

Regulations

1. Government Regulations That Control How Pesticides Are Used

The Health Protection Branch of Health Canada under the authority of the Food and Drugs Act decides on the amount of pesticide that may remain on the crop at harvest time (the "residue"). They set the "maximum residue limit" or MRL by considering the crop, the pesticide, and how often the food appears in our diet. Residues that are higher than these limits are against the law.

Pesticide Residues in Milk and Dairy Products

Health Canada does not allow any pesticide in dairy products. Any residues found in dairy products will be in violation of the Food and Drugs Act and Regulations.

Monitoring

2. Government Food Monitoring Programs

Both the federal government and the Ontario government carry out programs to check foods for pesticide residues.

Three examples of food monitoring programs carried out by Health Canada, Agriculture and Agri-Food Canada and the Ontario Ministry of Agriculture, Food and Rural Affairs are described below.

The **Health Protection Branch of Health Canada** establishes Maximum Residue Limits (MRL) and is responsible for enforcing these limits. They operate five regional laboratories across Canada where they test domestic and imported foods, such as fruit and vegetables, to ensure that residue levels are below the maximum.

Agriculture and Agri-Food Canada has tested fruit and vegetables for the presence of pesticides since 1987. Under the Canadian Agricultural Products Act, Agriculture and Agri-Food Canada enforces the law concerning pesticide residues by regularly testing samples of different foods. They include samples of produce grown in Canada and imported produce in their tests.

The **Ontario Ministry of Agriculture, Food and Rural Affairs** (OMAFRA) also monitors domestic and imported fruit and vegetables. This is part of a national program to monitor foods for pesticide contamination which the federal government co-ordinates with all the provinces.

The Plant Products Inspection Branch of OMAFRA can enforce the laws concerning pesticide residue levels under the Ontario Farm Products Grades and Sales Act. If pesticides are used according to label directions, residue levels will be below the maximum limit.

Reducing Use of Pesticides

These three monitoring programs for fruit and vegetables show how the federal and provincial governments work together to make sure our food contains only acceptable pesticide residues. If a test sample shows that the pesticide residue is above the limit, then federal and provincial officers investigate. The monitoring programs have shown that pesticide residues in fruit and vegetables are nearly always below the allowed limits.

3. Farmers' Agricultural Practices

In recent years, Ontario farmers have reduced their use of pesticides by using different methods to control pests. Ontario farmers reduced pesticide use by 17.4% between 1983 and 1988. Through education and research, OMAFRA is looking for ways to reduce or eliminate pesticide use while maintaining effective pest control.

The Ontario Ministry of Agriculture, Food and Rural Affairs encourages farmers to use Integrated Pest Management (IPM) Programs for their crops. This approach includes a combination of techniques to control pests. For example, OMAFRA monitors for pests in different crops to help the farmer decide when it is absolutely necessary to apply pesticides. Also, the farmer can reduce the amount of pesticides used by applying it right where it is needed.

Some methods to control pests without pesticides include:

- cultural (eg. - crop rotation)
- biological (eg. - using insects to control pests)
- mechanical (eg. - pruning fruit trees to remove branches infected with fire blight)

Information Sources

Farmers can learn more about reducing the use of pesticides by attending educational days organized by their pesticide vendor and/or government extension people. By following label directions and using the most current agricultural practices, farmers can help make sure consumers receive high quality food.

There are many Branches within the Ontario Ministry of Agriculture, Food and Rural Affairs that can answer your questions about pesticides, food safety, and IPM. Your local Ontario Ministry of Agriculture, Food and Rural Affairs office can help you find the information you want. Just call them. For information about federal regulations, contact Health Canada or Agriculture and Agri-Food Canada's Pesticide Information Line (1-800-267-6315).

Review Questions

1. Name three government departments that monitor food for pesticide residues:

2. What can farmers do to make sure that our food supply is safe?

Choosing the Right Pest Control

A **pest** is any harmful or troublesome organism. Pests include weeds, insects, diseases, fungi or even some animals such as rodents, deer or skunks. Integrated Pest Management (IPM) means you control the pest population to reduce the amount of economic damage which occurs. IPM involves using physical, cultural, biological, genetic and chemical practices alone or in combinations which give the best economical control. Before deciding on a pest management program, you must be able to answer these questions:

- Are the pests present?
- What type of pest (insects, weeds, fungi, animals)?
- How many pests are there per plant?
- How much damage is being done?
- Are conditions suitable for the pest to continue to grow?
- Is the pest at a stage where it can be effectively controlled? (To answer this you must understand the life cycle of the pest, habits and host of the pest)

Pest Identification

Correct identification of the pest is the key to effective pest management. Correctly identifying the pest lets you decide which control methods, if any, to use. The use of the proper pest control reduces the potential of damage to the environment and other organisms. Pests may be identified by:

- physical appearance
- damage caused
- life cycle
- habits
- method of reproduction
- host plant or animal

If you need help to identify the pest, contact the local Ontario Ministry of Agriculture, Food and Rural Affairs office, the local pesticide vendor or an agricultural college. OMAFRA factsheets and publications also provide useful information.

Once you know what the pest is, you must also find out the best stage and time to control it. A pest is usually more susceptible during one particular stage of its development. For example, annual weeds are easiest to control when they are young seedlings, but perennial weeds can be controlled with a herbicide application during the flowering period. To obtain the best control, the applicator must know:

- what the pest is
- when the pest can best be controlled
- which control method, if any, will control the pest.

Determine if Control is Necessary

All crops contain a certain number of pests. You must decide if the number of pests is large enough to need control. The damage from the pest population may not cost as much as the pest control operation, or the pests may become established in the crop when they can no longer do it any harm.

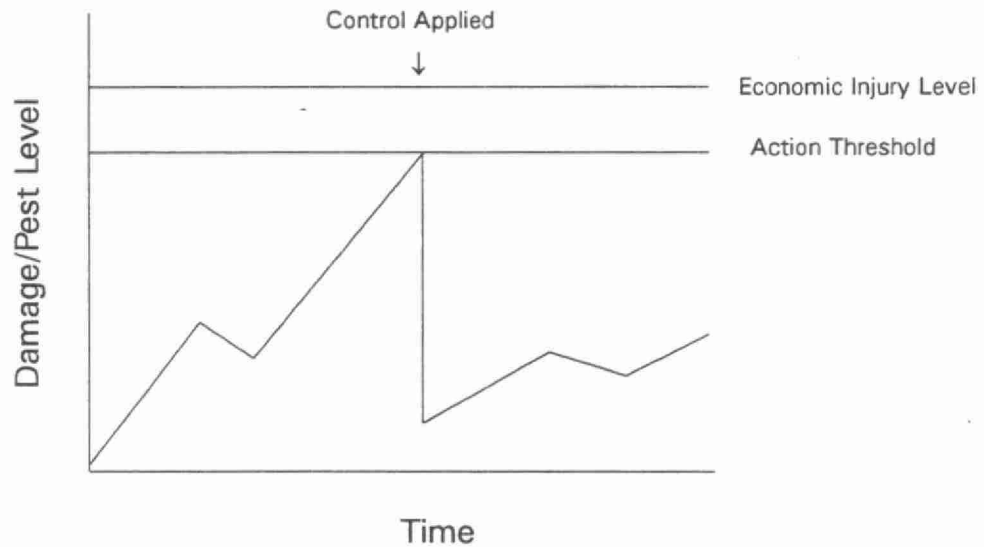
Your goal is to keep the pest population at a level that does not cause any economic loss to you. Control does not necessarily mean total elimination of the pest. Usually a certain amount of damage is tolerable. You should keep track of the amount of damage that occurs.

Action Threshold

You need to begin controls before the Economic Injury Level is reached. The **Economic Injury Level** occurs when the amount of damage caused by the pest is equal to the cost of controlling the pest. The **Action Threshold** is the point at which the pest is controlled to avoid reaching the Economic Injury Level. When the Action Threshold is reached, it is time to start controlling the pest.

Each pest has its own Action Threshold. Once you know the Action Threshold, you can monitor the pest population to know when the Action Threshold is reached.

Timing of Pest Control



Some methods you can use to monitor the pest are:

- collecting insects in traps
- counting number of pests in a certain area
- recording temperature, humidity, rainfall and leaf wetness as it relates to the spread of certain diseases
- scouting the area often to note any increase or change in the pest population or damage

Compare the pest population or crop damage to the Action Threshold. With this information you can decide if and when the pest needs to be controlled, and which methods to use.

Remember: If you need help it is available through:

- government publications
- pest management advisors
- research institutions such as colleges or universities

Whenever possible, supply the resource person with a sample of the pest or damaged plant or animal.

Pest Control Alternatives

A pesticide treatment is not always necessary or economical. Consider using methods of pest control that do not require chemicals. Alternative methods use physical, cultural, biological, or genetic control of the pest.

Physical control of pests involves removing the pest from the crop. Common examples of physical control include pruning fruit trees to remove fire blight, and cultivating fields to control weed populations.

Cultural methods of pest control include practices common to good land management. Cultural pest control includes crop rotation and planting certified seed (which is low in weed seeds and disease).







Biological methods of pest control use organisms to control or kill the pest. These methods include using parasites or predators. (e.g. - parasites to control whitefly in greenhouses)

Genetic methods of control include the release of sterile insects or selecting disease resistant varieties.

What is a Pesticide?

Pesticide is a general name for substances used to control pests like insects, weeds or diseases.

There are many different kinds of chemical pesticides. They can be grouped according to the specific pests they control. For example:

Type of pesticide	Controls
 insecticide	insects
 herbicide	plants - mostly weeds
 fungicide	different kinds of fungus
 rodenticide	rodents
 miticide	mites
 nematicide	nematodes (a kind of worm)

Less common pesticides include:

acaricide	mites, ticks
algicide	algae
avicide	birds
bactericide	bacteria
molluscicide	snails and slugs
piscicide	fish
growth regulators	plants, insects
adjuvants	stickers, wetting agents

Four groups of pests cause the most damage:

- insects
- diseases
- weeds
- rodents

One way to control these pests is by applying the right pesticide.

Choosing the Right Pesticide

After you have identified the pest, determined that a control measure is necessary and considered other methods of pest control, you may decide that the only practical method is to use a pesticide. You must now choose the best pesticide for the job.

The pesticide should:

- **be effective** against the pest
- **be registered by Agriculture and Agri-Food Canada** for use on both the crop and the pest
- **be classified in Ontario** by the Ministry of Environment and Energy
- **fit in with the work schedule.** Take into account the minimum amount of time before you can re-enter the field (specified on label) so that the pesticide application does not interfere with other operations, like trimming, harvesting or packing.
- **complement the harvest date.** Some pesticides must be applied a specific number of days before the harvest to reduce pesticide residues in the fruit crop. The number of days is shown on the pesticide's label as "days to harvest interval".
- **present the least hazard** to the applicator and others who could be exposed to the application. The symbols on the label show you the hazards of the product.
- **have the least effect on beneficial species.** For example, bees are required for the pollination of many crops. If bees are foraging or are located nearby, use a product with low toxicity to bees and spray at a time when bees are not foraging in the crop. Never apply insecticides while fruit trees are in bloom.
- **discourage pest resistance.** If the pest is resistant to a pesticide product or has developed resistance at other locations, choose another product. Consult the local Ontario Ministry of Agriculture, Food and Rural Affairs office for advice.
- **be compatible.** If you must apply more than one pesticide, check the label for information about compatible products.
- **minimize exposure.** Select the formulation type which will minimize exposure for the applicator during mixing and loading and provide the minimum injury to the crop.

- **be right for the application equipment available.**
- **control secondary pests.** If secondary pests are present, select a product to provide the most effective control.

Resistance to Pesticides

Occasionally a few pests from a pest population are not affected by the use of a pesticide. These pests have developed a **resistance (or tolerance)** to the chemical. These pests will, in turn, reproduce and the young, like their parents, will not be affected by the pesticide. Once the cycle of resistance starts, it may be difficult to control the pest.

How Can You Slow the Development of Pest Resistance

You can slow the development of pest resistance by:

- using different control methods such as biological, physical, cultural and genetic controls
- only using pesticides when needed
- using pesticides from different chemical families, e.g. - triazines or phenoxy

Environmental Conditions

Before making a decision about the pesticide you would use, you should consider the environmental conditions at or near the treatment site. The conditions can affect the safety of man, animals, and the environment, as well as the effectiveness of the control methods.

What Conditions Should You Consider?

Temperature - Some pesticides require a certain temperature to work effectively. Many pests are only active within a certain range of temperatures.

Relative Humidity - Many plant diseases require high humidity to develop and spread.

Precipitation - Rain soon after the application of some pesticides will wash away the chemical. In other instances, rain may control the pest (e.g. - aphids, spiders, mites)

Air Movement - Pesticides and pests can be carried from the targeted area by the movement of air.

Topography - Rolling or steep land, nearby waterways, and other land features, e.g. - soil type, may limit the use of certain pesticides.

Nearby sensitive areas - Avoid applying pesticides near environmentally sensitive areas (e.g.- wetlands).

Always check the pesticide label for warnings of any environmental hazards

Recording and Evaluating Pest Management Results

Detailed records of all pest management practices should be kept. This information is useful to:

- evaluate the effectiveness of the current pest management program
- modify the pest management program in subsequent years
- forecast pest problems
- defend liability suits

More information on pest management systems may be obtained from government publications, magazines, pest management advisers, local colleges and universities. (see also Keeping Pesticide Records)

Review Questions

1. Using pest management techniques results in the most economical control of pests.

TRUE

FALSE

2. Define Economic Injury Level.

3. List 4 methods of Pest Control that do not involve the use of pesticides. Give an example of each.

4. A herbicide is one type of pesticide.

TRUE

FALSE

5. Describe 2 ways to slow the development of pest resistance.



Weeds and Their Control

Weeds

A weed is any plant which grows where it is not wanted. Weeds compete with other plants in the environment for food, water, sunlight and space.

Knowing the name of the weeds and knowing about their growth habit and life cycle will help you to control them. If you cannot identify a weed, take the weed to your local Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) office. They will help you identify it and suggest methods of control.

Life Cycle

Weeds can be classified by how long it takes them to complete their life cycle from seed to seed.

Annual Weeds

Annual weeds complete their life cycle within one year. Many annuals produce numerous seeds to ensure their survival. Annuals can be divided into two groups:

Summer Annuals: Summer annuals germinate in the spring and die that same fall. (e.g. - common ragweed, wild mustard)

Winter Annuals: Winter Annuals germinate in the fall and die the following summer. (e.g. - shepherds purse, stinkweed)

Biennial Weeds

Biennial weeds take two years to complete their life cycle. They grow from seed which usually germinates in the spring. The first year they store food, usually in short fleshy roots. Usually the foliage is only a rosette of leaves. Next season the plants use the stored food, grow vigorously and produce seed in the summer or fall and then die. (e.g. - wild carrot or burdock)

Perennial Weeds

Perennial weeds are plants that live more than 2 years. Often no seed is produced the first year; thereafter seeds can occur every year for the life of the plant. Almost all perennial weeds spread by seed. Many also spread by other plant parts such as creeping stems, creeping roots, rhizomes a root-like underground stem (quackgrass), underground bulbs (wild garlic) or a broken piece of root (dandelion). Perennials may be shallow rooted or deep rooted.

Weed Characteristics and Growth Habits

Each weed has its own set of characteristics and growth habits which will help you in identifying it. Once you know what the weed is you can decide on the best chemical to use. Characteristics which will help you in the identification are:

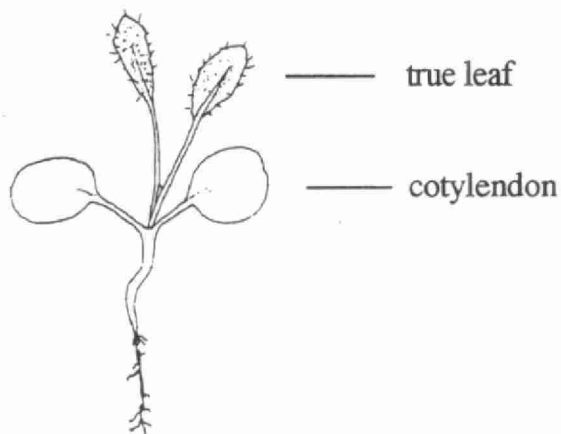
- leaf shape and surface
- leaf margins-serrated, smooth, lobed
- arrangement of leaves on stem (opposite, alternate, whorled)
- branching habit
- flowering colour, shape and habit
- woody or herbaceous stems

Leaf Stages

Also, you must take note of leaf stages of the weed. For example, a pesticide may recommend application at the three leaf stage. Use of the pesticide before or after this stage will reduce the effectiveness of the pesticide and could result in poor weed control. The weed is growing continually and stages will change rapidly. Careful monitoring of the plant's growth will be necessary to make sure that the pesticide is used at the right time.

Leaf Stages of Broadleaf Plants

The first leaves to appear on the stem after the plant emerges are called **cotyledons**. The cotyledons are usually a different shape than the **true leaves** and may dry up or disappear as the plant develops. On a few plant species, the cotyledons remain beneath the soil surface. When counting leaf number to decide when to apply a pesticide you do not count the cotyledons.



The **true leaves** may be arranged on the stem **alternately** (grow from alternate sides of the stem), **opposite** (grow opposite each other on the same node), or in a **whorl** (groups of 3 or more leaves growing from the same node on the stem.)



alternate



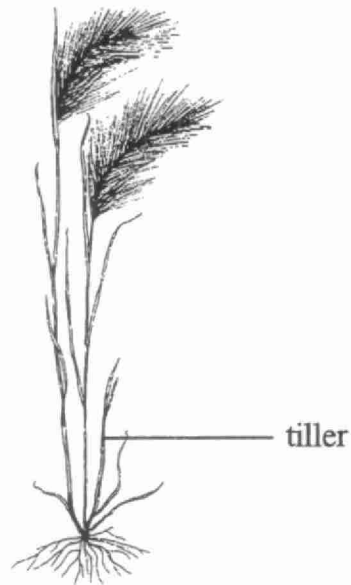
opposite



whorl

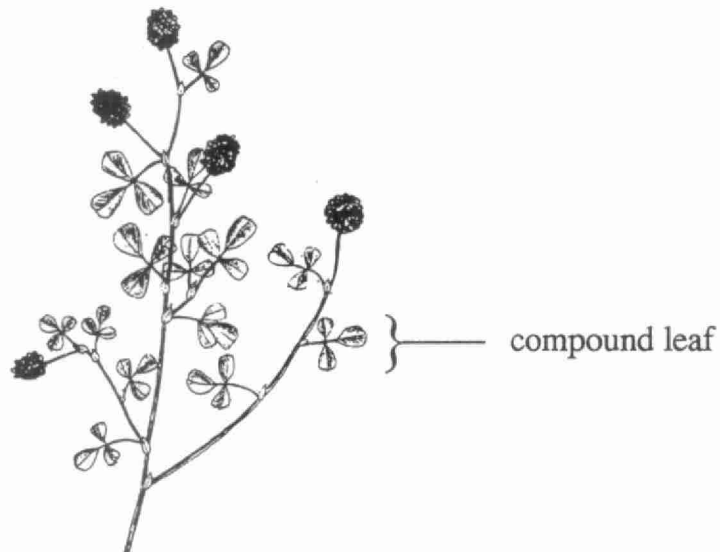
Leaf Stages of Annual Grassy Plants

Grass leaves generally unfold from a central whorl. Each leaf of the main shoot should be counted. **Tillers** are the secondary shoots of a grass plant which emerge from the base of the leaves, generally at the three to five leaf stage. Tillers should not be included in the leaf count.



Leaf Stages of Legumes

Most legumes, such as white clover, have **compound leaves**. Compound leaves are made up of several leaflets on a single stalk. When counting the leaves, each compound leaf is counted as one. **Do not count each leaflet.**



Weed Control

Weeds are usually controlled using the following methods:

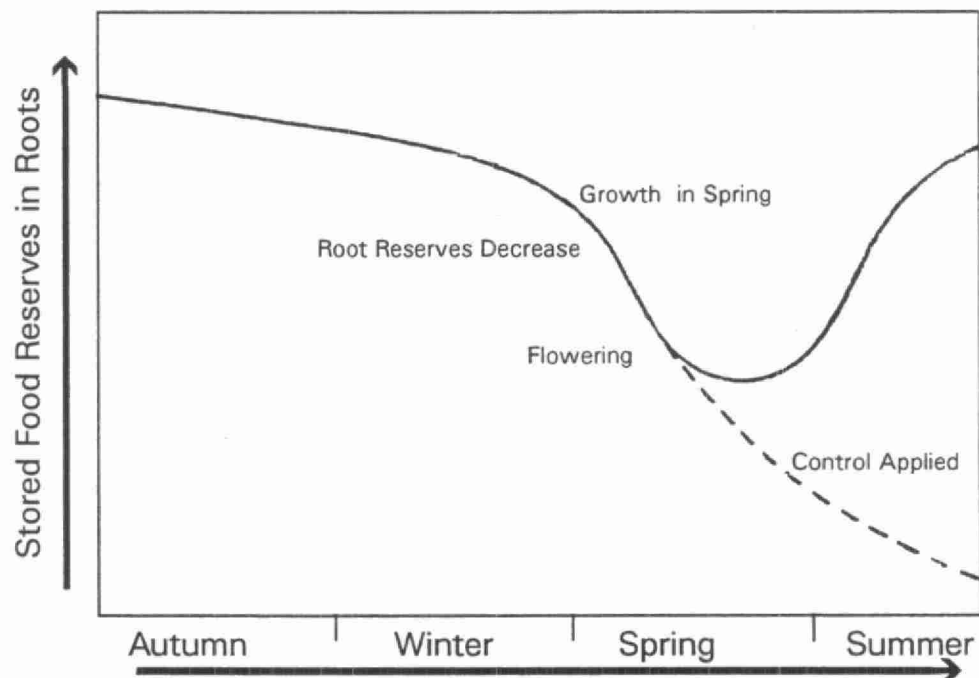
- physical (cultivating, hoeing, mowing)
- biological (grazing the crop before the weeds go to seed)
- cultural (growing crops to compete with the weeds which may become a problem)
- chemical (using herbicides)

Weeds should be controlled before they compete with the crop and before they produce seeds. You may be able to control these weeds by tilling, mowing, or spraying.

Perennial weeds are hard to control. You must stop the seeds from spreading and destroy the underground stem and root systems. A herbicide must be able to move down a plant to the root to kill it completely. The control you use depends on many things, including the weed, the crop, and the time and place of control.

Root reserves of perennials begin to decrease as the plant grows in the spring and are at their lowest during flowering time. Weeds flower at different times, and some weeds, such as Sow Thistle, will produce flowers again, even after mowing. Although it may be difficult, control measures are most effective when perennials are flowering.

Using Root Reserves to Kill Perennials



Herbicides

Herbicides are chemicals used to control weeds. They can be grouped into categories depending on:

- how they work (mode of action)
- what kind of plants they control (selectivity)
- how long they control the weeds (residual control)

How Herbicides Work

1. Contact and Systemic Herbicides

Contact herbicides kill only the parts of the plant that the chemical touches. To kill the whole plant, the herbicide must contact most of the plant's surface.

Systemic herbicides kill weeds by moving throughout the plant's system. They prevent the plant from growing. Herbicide effects may not show for a week or more after treatment. Too much herbicide on the leaves may kill the leaf cells too quickly and prevent movement through the plant.

2. Selective and Non-selective Herbicides

Selective herbicides kill certain plants without killing others. When used at the proper time and rate, these herbicides can control specific weeds within a crop. For example, some herbicides control broadleaf weeds but not grasses.

Non-selective herbicides are used to control all the plants within the treated area.

When to use a Herbicide Treatment

To get the most benefit from a herbicide, you must apply it at the right time. The chemical must kill the weeds without damaging the crop. The time will vary depending on the crop and the herbicide you use. Recommendations on the most effective and safest time to apply the herbicide can be found on the label.

There are three different times when herbicide treatments may be used:

1. **Pre-plant treatments** - Herbicides may be applied before the crop area is sown or planted. This treatment usually kills weed seeds or seedlings as they begin to grow. Some of the pre-plant herbicides are very volatile and will be quickly lost into the air. They are, therefore, worked into the soil immediately after application. These herbicides are referred to as **Pre-plant Incorporated** treatments.
2. **Pre-emergence treatments** - Herbicides may be applied after seeding but before the weeds or crop emerge. A layer of the chemical rests on top of the soil so that weed seeds cannot germinate and young seedlings cannot survive. For pre-emergence treatments to be successful, the crop seedlings must be able to resist the chemical, or the effects of the chemical must disappear before the crop emerges.

To get the best results from pre-emergence treatments, you need a well-prepared seed bed, and warm, moist soil conditions.

3. **Post-emergence treatments** - Herbicides may be applied after the crop and weeds have emerged. Choose a selective chemical which will kill the weeds without damaging the crop.

Sometimes a herbicide may be applied after the crop emerges, but before the weeds do. For example, you may cultivate your crop, then apply a herbicide to the weed free soil to control germinating weeds.

How Well Herbicides Work

There are many factors which affect how a herbicide works on weeds. These are:

- leaf structure
- weather conditions
- growth stage
- soil type
- soil moisture
- cultivation
- resistance
- fertility

Leaf Structure

Plants with thin upright leaves such as grasses are hard to cover with spray. Hairy or waxy plant surfaces may affect how much of the herbicide actually contacts the plant surface. Surfactants or surface active agents can be added to the herbicide formulations to increase the wetting and sticking ability of the spray so it won't bead up or run off. The surfactant also helps the herbicide to cut through the waxy surfaces and aid penetration into the leaf. The herbicide label will tell you when to add a surfactant and may even recommend the best surfactant to use for the most satisfactory results. **Always follow the label directions.**

Weather Conditions

Temperature, humidity, rain and wind may affect herbicide effectiveness. It is usually better to apply herbicides under moderate conditions rather than extreme conditions (e.g. - cold, rainy days, or extremely hot days). The label will indicate what weather conditions should be avoided and what the best weather conditions are in which to apply the herbicide.

Cool, dry conditions slow the process of food production and movement through the plant and reduce the rate of movement of the systemic herbicide. Hot dry weather may make the herbicide evaporate quickly from the weed leaves and therefore reduce effectiveness. Hot dry weather may also increase the volatility of a pesticide. Rain during or after an application can wash the herbicide off of the plants. However, some herbicides may require a rain or irrigation after application to activate them. The label is the best source of information as to the best conditions under which to apply the herbicide. Herbicide application under windy conditions will cause drift and prevent the herbicide from reaching the target and may instead carry the herbicide to an undesirable target.

Growth Stage

Herbicides are often more effective on young rapidly-growing weeds. Systemic herbicides which move with the food and water can spread faster in rapidly growing younger weeds than in older plants. Herbicides are less likely to kill annual or biennial plants which are in full flower or producing seed.

Weeds often become more resistant to herbicides as they grow older, but may become more susceptible again in the bud or early flowering stage. At this stage the herbicide will move through the plant to the roots, to be stored with the food supply. As a result the root will die.

Soil Type

Soils high in organic matter (peat or muck) and fine textured soils (clay or silt) hold the herbicides close to their surface and therefore reduce the amount of herbicide that is available to control weeds. These soil types may require a higher application rate than other soil types such as sand. Sandy soils may require lower levels of herbicide, perhaps more frequently as the herbicide may leach with the soil water more quickly. The herbicide label will tell you what rate of application is needed for effective control of the weed in the crop you are targeting. **Never apply more herbicide than is recommended on the label!**

Soil Moisture

Herbicides applied to the soil generally work best in warm, moist soil. The moisture and warmth enhance plant growth and therefore help move the herbicide into the weeds.

Cultivation

Cultivating before a herbicide application can make herbicides more or less effective depending on the weed and the herbicide. Some weeds may be weakened by cultivation and become easier to control while other weeds may be broken into pieces and be harder to control. **Read label directions first to see if it is beneficial to cultivate before or after the herbicide is applied.**

Review Questions

1. Match the type of control with the examples given.

physical —

biological —

cultural —

chemical —

a. herbicide

b. rotation

c. grazing

d. hoeing

2. When is the best time to kill perennial weeds?

3. You must get good coverage to kill a weed with a contact herbicide.

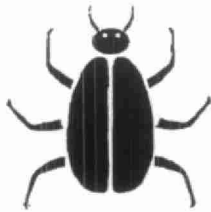
TRUE

FALSE

4. Define an annual weed.

Insects and Their Control

Insects



Insects are grouped into families according to characteristics, eating habits, and life cycles. The visual characteristics are:

- winged or wingless
- mouth parts: chewing, sucking, rasping, sponging
- antennae: long, short, segmented, non-segmented, feathery, non-existent
- body segments: head, thorax, abdomen - relative size, colour, texture

Some insects are carnivores (e.g. - preying mantis), they eat other insects. Others are herbivores (e.g. - grasshoppers), they eat plants.

Insects will begin their life cycle as an egg, but the next stage or stages depends on the type of life cycle they have. An insect will complete 3 or 4 stages in the life cycle as it grows. Each change is referred to as a **metamorphosis**. There are three possible life cycles:

- no-metamorphosis
- incomplete metamorphosis
- complete metamorphosis

Insect Development

In the **no-metamorphosis** life cycle the insect passes through 3 stages: **egg; young; adult**. The young look like the adult but are less developed (silverfish).

In the **incomplete metamorphosis** life cycle an insect completes 3 stages: **egg; nymph or naiad; adult** (grasshopper). The nymph or naiad stage resembles the adult, only smaller and it may be lacking something such as wings. As the insect grows, it sheds its layer of skin and grows a new one.

In the **complete metamorphosis** life cycle an insect completes 4 stages: **egg; larva; pupa; adult** (beetles, corn rootworm, ants). The larvae is the young, wingless feeding stage (such as caterpillars, loopers, grubs or maggots). The pupa is a resting stage during which a complete change of shape occurs.

It is important to recognize the stages of the insect as pesticide control is specific to certain stages. The most effective control is generally applied at the larval stage. The pupa and egg stage are difficult to locate and are seldom affected by the pesticide. The adult stage must be controlled before the eggs of the next generation are laid. It is not always possible to time this effectively.

Insect Life Cycles

No Metamorphosis

egg → young → adult

(eg. Silverfish, Firebrats, Springtails)

Incomplete Metamorphosis

egg → nymph → adult

(eg. Grasshoppers, all Bugs, Earwigs, Thrips)

Complete Metamorphosis

egg → larva → pupa → adult

(eg. Bees, Wasps, Beetles, Moths, Butterflies, Flies)

Note: The number of moults in the young, nymph or larval stages vary with the insect species.

Insect Control

Insects and mites can reduce the quality and yield of many crops. They feed on the roots, stems, leaves and fruit of the growing plants. They can spread diseases from plant to plant and from field to field. They may also attack the harvested crop while it's in storage. The main reason to control insects is economic - to maintain the potential value of your crops.

Insecticides

Insecticides and miticides are often described according to how they work (mode of action).

How Insecticides Work

1. Stomach and Contact Insecticides

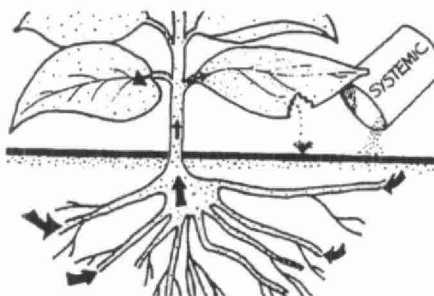
The earliest insecticides, called **stomach insecticides**, were poisons that were sprayed on the crop's leaves. These products poisoned the insects when they ate the treated crop.

New products, called **contact insecticides**, poison the insects on contact. Dust particles or spray droplets may hit the insect directly or be picked up as the insect moves across a sprayed area. The poison is taken in through the insect's body.

Today most insecticides are both stomach and contact insecticides. Good spray coverage is very important when applying this kind of insecticide. The better the spray coverage, the greater the chance that the insects will touch or eat the pesticide.

2. Systemic and Non-systemic Insecticides

Systemic insecticides can be applied to one part of the plant (such as the root or the leaf) and they will move throughout the plant to make the whole plant poisonous or toxic to insects.



Non-systemic insecticides do not move throughout the plant. They stay where they were applied. The insect must eat or touch a portion of the plant that was treated with the insecticide.

Points to remember about Systemic Insecticides

- Some systemic insecticides require a certain application method to be effective. Some must be applied to the root area. Others must be sprayed on the crop's leaves.
- The amount of chemical you apply to the plant is very important. Be sure to use the right amount to give the best control.
- You must allow enough time for the insecticide to move throughout the plant before the insects begin to feed on the crop.

Remember to read the label for complete instructions about how to use systemic insecticides effectively.

3. Suffocating Insecticides/Miticides

Suffocating Insecticides/Miticides (usually oils) clog the breathing system of insects and may also affect egg survival. (e.g. - dormant oil for the control of scale insects)

4. Fumigants

Fumigants are insecticides that work in a gaseous or vapour form. The pests breathe the poisonous fumes. Fumigants are often used to kill pests in enclosed spaces or in soil. (e.g. - grain bins)

5. Growth Regulators

Growth Regulators act like the insect's own hormones. They affect the normal development of the insect and it dies before it becomes an adult or before it can reproduce.

6. Attractants

Attractants are chemicals which may attract female insects for egg laying or attract male insects to artificial female traps.

7. Insect Repellents

Repellents are pesticides which repel insects and will therefore keep the pests away from their hosts. They are usually used against mosquitoes and biting flies. Examples are moth balls or crystals, and pet collars.

8. Sticky Pastes

Sticky Pastes are ointments that contain pesticides. Attractants, such as colours, are used to attract the insects to the trap. Examples are insect strips, and wood preservatives.

9. Microbial Insecticides

Microbial Insecticides contain microbes (tiny organisms). After they are eaten, the microbe or a poison the microbe produces kills the insects. They are sprayed on plants and are only poisonous to certain insects.

There are factors which affect how an insecticide works. These include:

Timing of Application

The timing of application depends on the stage of development of the pest. Contact insecticides may require the presence of the pest to be effective.

Resistance

Some insects/mites have developed resistance to certain pesticides or groups of insecticides.

Weather conditions

Temperature, humidity and rain can affect the effectiveness of insecticides.

Review Questions

1. Each change in an insect's life cycle is known as a metamorphosis.

TRUE

FALSE

2. An insect that goes through complete metamorphosis has the following stages in its life cycle.

a) egg; young; adult

b) egg; larva; pupa; adult

c) egg; nymph or naiad; adult

3. A systemic insecticide moves throughout the plant and makes the whole plant toxic to insects.

TRUE

FALSE

4. Contact insecticides:

a) are effective if eaten by the insect.

b) can poison insects through contact with the insect's body

c) must be applied to the soil surface to be effective

d) both a) and b) are correct

e) all of the above

Diseases and Their Control

Disease

A healthy plant can become diseased when any change is made to the plant's environment or life process. Disease, unlike injury, does not heal itself. It will continue as long as the cause remains. Disease symptoms can be caused by environmental stress such as temperature and moisture or by pest infection such as damping off caused by fungi. It is important that you correctly identify the cause of the symptoms so that you can decide on an effective treatment.

Environmental Stress

Problems caused by environmental stress can not be controlled by pesticides.

Unfavourable environmental conditions will stress plants and cause abnormal growth or disease-like symptoms. These conditions may include extremes of light, temperature, water or nutrients and air pollutants. Plants weakened by environmental stress are more likely to be infected by pests. Recognizing the stress symptoms and correcting the problem will help prevent the plant from becoming diseased.

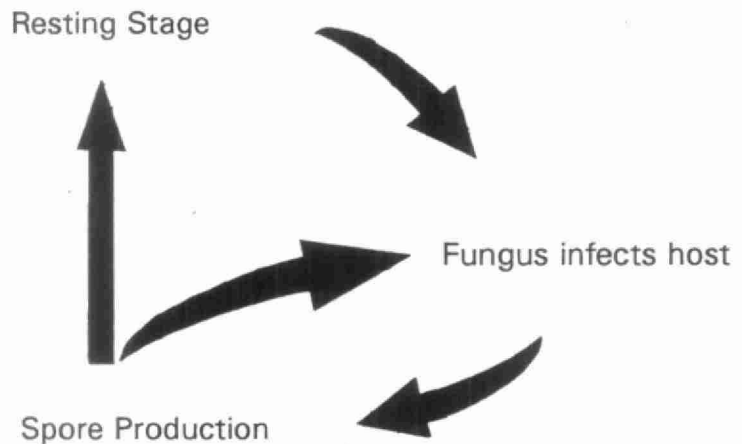
Pest Infection

Pest organisms can cause diseases. The organisms include fungi, bacteria, viruses and nematodes. All of these organisms are usually too small to see. Identification is usually based on the symptoms that can be seen.

Fungi

Fungi are the largest group of organisms which cause plant diseases. They are simple plants which feed on living or decaying organisms. This group includes moulds, mushrooms and rust. Most fungi reproduce by tiny spores. When spores germinate, they usually produce threadlike filaments (mycelium) which absorb nutrients from the host and release chemicals that cause disease symptoms. The life cycle of many fungi follow a similar sequence.

Life Cycle of Fungus



Some fungi such as the rusts need 2 different hosts to survive and reproduce. This means that the fungus overwinters on one type of plant, spreads its spores to another type of plant in the spring and reproduces. The fungus cannot complete its cycle if one of the plants is not present. An example of a rust disease requiring 2 hosts is the Cedar-Apple rust. To identify the fungus, examine the damaged area. Look for mycelium or spores and anything that is abnormal. This could include wilting, yellowing, decay, stunting cankers, dieback, galls, leaf spots, rots, rusts and wilts. Then consider the growing conditions. Are the growing conditions favourable to a disease causing fungi?

Check the following:

- kind of plant
- amount of damage
- date damage first appeared
- size of the damaged area
- shape of the damaged area
- weather conditions
- watering
- fertilizing
- time of year

These clues will help you diagnose the disease and identify the fungus. You can then decide on the best control.

Bacteria

Bacteria cause some major plant diseases. Bacteria are one-celled organisms which can only be seen with a microscope. They usually enter a plant through natural openings or wounds. In favourable conditions, bacteria reproduce very quickly, using the plant as a source of food.

Bacteria may be spread by people, animals, equipment, wind, rain and insects. Some blights, galls and rots are caused by bacteria. Examples are fire blight in pear and some vascular wilts in vegetables.

Viruses

Viruses are extremely small organisms which grow inside living cells. Viruses cause diseases which often reduce plant vigour and crop yields. Viruses only reproduce when they are in living cells. Viruses can be spread by mechanical means (e.g. - during pruning or harvesting), in propagation material (seeds, tubers and other plant parts), and may also be spread by insects, mites, nematodes or fungi. There are limited pesticide controls for viruses.

Nematodes

Nematodes are small, thread-like worms which may feed on plant stems, leaves and roots. They can affect the movement of water and nutrients in a plant and they create wounds which let fungi or bacteria enter. Nematodes are spread by infected plant material. They also remain in infected soil and will contaminate future crops. Symptoms of nematode infection are wilting, stunted growth and lack of plant vigour.

Disease Control

The key to disease control is to control the factors which allow the disease to exist. These three factors are:

- a disease causing organism must be present such as bacteria, fungus or virus
- a host susceptible to the disease must be present
- an environment favourable for the disease to develop, e.g. - dampness or cool temperature

Once you eliminate any one of these factors you will be able to control the disease. Steps you may take are:

- growing varieties that are resistant to a certain disease that you know to be in the area
- eliminate debris or other plant material that you know carries the disease
- use crop protectants that will prevent the disease from entering the plant
- remove plants known to act as a host for a certain disease such as cedar trees near an apple orchard

You can control disease by keeping the plants healthy. This may or may not include using fungicides. To keep the plants healthy, give them the water and nutrients they need. Both over and under application of water and nutrients can lower a plant's resistance to fungi that cause disease. A damp plant environment gives fungi a chance to thrive also. Nitrogen is the food for both the plant and the fungi. Try to give the plants a balanced diet, avoiding over application of any nutrients.

Fungicides

Moulds, rots, rusts and wilts can be controlled by fungicides. Fungicides are chemicals that either kill the fungus or stop its spores from germinating.

Fungicides can be applied to the growing crop or to the seed before planting. Fungicides are applied as **protectants** or **eradicants**.

1. Protectants

Protectants protect the plant from diseases. These fungicides must be applied to the plant or seed before the disease occurs. They form a protective layer on the plant's surface for a week or more. Once the chemical wears off or new plant growth occurs, there is no longer an effective chemical shield between plant and fungus. Spraying every seven to ten days, or on a weather-timed schedule, ensures that the plants are protected at all times. These fungicides are routinely used in orchards and vegetable crops.

2. Eradicants

Eradicants control diseases which have already infected the plant. These fungicides penetrate into the plant and kill the fungus before it causes damage. Eradicants work best when there is good coverage of all plants.

Bactericides

Bactericides are chemicals that prevent bacterial infections. They kill bacteria on contact and must be used before the bacteria infect a plant.

Nematicides

Most pesticides used for nematode control are fumigants. Fumigants move through the soil as a gas and depend on the presence of air spaces in the soil for their movement. The soil must be covered with an impermeable cover to prevent the fumigant from escaping into the air and lessening the effectiveness in the soil. Many fumigants are highly toxic and require a permit for application.

How Well Pesticides Work

As with all pesticides, correct application timing is very important to have effective control. **Always read the label for correct application information!**

Review Questions

1. Disease is caused by pests such as fungi, bacteria, nematodes and viruses.

TRUE

FALSE

2. Pesticides that are **eradicants** must be applied to the plant or seed before the disease occurs.

TRUE

FALSE

3. Pesticides that are **protectants** must be applied to the plant or seed before the disease occurs.

TRUE

FALSE

Animal Pests and Their Control

Animal Pests

Animal pests include:

- birds
- rodents
- skunks
- regional pests such as ground hogs, bats, wolves, raccoons, deer

Animals are pests when they:

- damage property, crops, feed, food or livestock
- carry diseases affecting man or animals

Be careful to weigh the benefits and the drawbacks to the damage caused when planning pest control programs for these pests.

Pest Behaviour

Knowing the animal's behaviour and biology is important as it helps determine the most effective control methods, the best time to implement the control and the best location for the control (e.g. - traps or poisoned baits.)

The selection of effective control methods will depend upon:

- population density
- mobility of the pest
- habitat of the pest
- preferred foods of the pest
- availability of food
- pest's wariness of man and foreign objects
- predators of the pest

The best time to implement a control will depend upon:

- availability of food
- when migration takes place
- when population numbers are lowest (just before young are born). Controls should be set in place before this time.
- when the pests are actively moving about in search of food
- whether the pest hibernates

The best locations to trap, shoot or poison an animal pest can depend upon finding:

- the den
- the burrow or nest and exits
- the regularly travelled routes
- the feeding areas

Once you have identified the pest problem, you will be able to consider a **Pest Management Program**.

Animal Control

Animal pests may be controlled by:

- removing the pests from a feeding or breeding location
- destroying their habitat
- encouraging natural predators
- frightening away or repelling the pests
- shooting the pests
- trapping the pests
- preventing reproduction of the pests with chemical sterilants
- poisoning the pests with pesticides (including avicides and rodenticides)

The control measure chosen depends on:

- the legal status of the control measures
- the cost of these controls
- their effectiveness

Legislation for the protection of wildlife may prevent the destruction of some pests or may require special permits for their control. Shooting, trapping and the use of pesticides may be limited to specific times of the year or specific locations. **Check with federal, provincial, and/or municipal authorities before using any control measure to control an animal pest.**

Rodenticides

Rodenticides are pesticides which kill rodent pests such as mice and rats. Most rodenticides work by preventing blood-clotting. Rodents that eat treated bait die from internal bleeding after three or four days. Any animal that eats enough of the bait, from birds to the animals that prey on rodents (snakes, hawks, raccoons), will eventually bleed to death.

Most rodenticides are sold as bait. Follow the label directions carefully, and take care to prevent other animals from being killed. Construct rodent bait stations to prevent other animals from feeding on the bait. Keep bait stations inside, unless the label says the bait may be used outside. Never broadcast the bait near wildlife or domestic animals.

Review Questions

1. Rodenticides are pesticides which kill rodent pests such as mice and rats.

TRUE

FALSE

2. List 2 control methods (other than pesticides) which would allow you to control animal pests.

Selecting and Purchasing Advice to Customers

A person who sells pesticides has a responsible job. A vendor should be able to help the customer select the proper pesticide. Helping your customers to carefully plan their pesticide purchases can reduce the amount of pesticides the applicator will need to use and store.

Reference Information for Vendors

Each year the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) updates their publications on pest control methods. Reviewing these publications and knowing how to find information will help you provide information to your customer.

OMAFRA Publications

Pub. #	Title
64	Insect and Disease Control in the Home Garden
75	Guide to Weed Control
296	Field Crop Production Recommendations
360	Fruit Production Recommendations
363	Vegetable Production Recommendations
365	Pest Management Recommendations for Ontario Greenhouse Crops
383	Production Recommendations for Nursery & Landscape Plants
384	Recommendations for Turf Grass Management

Pesticides Used on Livestock

A number of Ontario Ministry of Agriculture, Food and Rural Affairs Fact Sheets are available from your local Ministry office. These include:

AGDEX	Title	Order #
<u>419</u> 653	Fly Control in Barns & Stables	83-019
<u>420</u> <u>655</u>	War on Warbles	84-006
<u>410</u> 653	Fly & Louse Control on Dairy Cattle	87-050
<u>420</u> 653	Fly & Louse Control on Beef Cattle	86-009
<u>440</u> 675	Lice & Mange Mite Control on Swine	85-046

The Ontario Schedules for all pesticides will be available from your supplier. Here are some examples of animal pesticides classified as Schedule 2 in Ontario. **For a complete list of all pesticides classified in Ontario, refer to the Ontario Ministry of Environment and Energy's Publication "Pesticide Products Classified in Ontario".**

Baytex Spray Concentrate Barn Insecticide
 Clean Crop Lindane Insecticide for Livestock
 Coral Animal Insecticide 25% Wettable Powder
 Cygon 4-E
 Kemsan Barn & Livestock Spray
 Kemsan Barn & Livestock Spray with Repellent
 Lindane 11% Livestock Insecticide
 Lysoff Pour-on for Lice
 Purina Cygon 4-E Systemic Insecticide
 Purina Mange Control
 Spotton Cattle Insecticide
 Stockpest Louse Spray Concentrate
 Vectobac 200 G

Review Questions

1. This pesticide recommendation was taken from OMAFRA Publication 363. Fill in the chart.

European Corn Borer - Sweet Corn			
	Re-entry Period	Interval To Harvest	Ontario Schedule
AMBUSH (permethrin)			
RIPCORDER (cypermethrin)			
FURADAN (carbofuran)			
LANNATE (methomyl)			

2. This pesticide recommendation was taken from OMAFRA Publication 360. Fill in the chart.

Plum Curculio - Apple			
	Re-entry Period	Interval to Harvest	Ontario Schedule
GUTHION (azinphos-methyl)			
IMIDAN (phosmet)			
ZOLONE (phosalone)			
BELMARK (fenvalerate)			

3. List two brand names, formulation types and concentrations under which metribuzin (a herbicide) is sold - Publication 75.

Brand Name	Formulation Type	Concentration of a.i.

4. Name two insecticides which have a 48 hour re-entry period.

1. _____
2. _____

5. What is the Ontario Schedule of:

Pesticide	Ontario Schedule #
BRAVO (chlorthalonil)	
captan	
parathion	

6. A homeowner has a chinch bug problem on his/her lawn:

a) What are the common names of the insecticides that could be used to control chinch bugs?

b) Name three pesticide products you could recommend:

Application Equipment



Equipment for applying pesticides can be simple (such as a hand-held squirt bottle) or complex (such as multiple-nozzle pressure sprayers). When you select your equipment, consider: the size and type of area to be treated, the type of pest, the pesticide formulation and the recommended method of application.

Remember - any equipment requires regular maintenance to keep it working properly. Maintenance is especially important for pesticide application equipment to make sure that the right amount of pesticide is applied evenly every time.

This section reviews the main types of application equipment and describes basic sprayer parts and maintenance.

Hand-Operated Sprayers

Hand-operated sprayers are often used to apply small quantities of pesticide for spot spraying. Most are operated with compressed air which is supplied by a hand-pump. The disadvantages of hand-operated sprayers are that the pressure and output rates may vary. Also they often do not provide sufficient agitation to keep wettable powders in suspension. Some examples of hand-operated sprayers include the following:

Pressurized Cans (aerosols)

Small non-reusable cans with a capacity of less than 1 L are available for home use.

Pressurized Cylinders

Large reusable cylinders with the contents under pressure are available for pest control in buildings, agricultural crops and greenhouses.

Trigger Pump Sprayers ('squirt gun' sprayer)

The pesticide container is not pressurized. Instead, the pesticide and carrier are forced through the nozzle by pressure created when the trigger is squeezed.

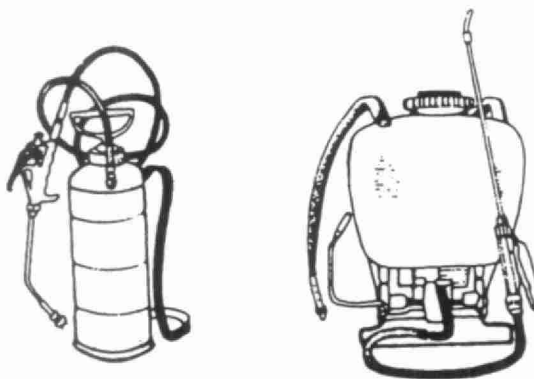
Hose-end Sprayers

In this type of sprayer, a small spray-tank containing concentrated pesticide is attached to the end of a hose. A preset amount of pesticide is drawn from the spray tank by suction and mixes with the water flowing through the hose. This type of sprayer may deliver 50 L or more of spray solution before it needs refilling. The major disadvantage with these sprayers is that they are not reliable. Any dirt in the nozzle can change the amount of pesticide in the mix.

Compressed-air Sprayers

This type of sprayer operates under pressure, usually supplied by a manual pump which fits into the top of the spray tank. Compressed air above the spray mixture forces the liquid out of the tank through a hose and nozzle. These sprayers may be hand-held (capacity 4 to 10 L) or back-pack units (capacity up to 25 L). Some compressed-air sprayers are equipped with pressure gauges for accurate pressure control. Some nozzles are equipped with a shutoff at the tip to avoid drips when spraying is stopped. Operating pressures for hand-operated sprayers are usually between 100 and 600 kPa.

Another type of compressed air sprayer uses a pre-charged cylinder of air or carbon dioxide to provide pressure. These units include a pressure-regulator valve to maintain uniform spray pressure. Pesticides may be applied through a handgun or a short boom.



Push-pull Hand Pump Sprayers

A hand-operated plunger forces air out of a cylinder and creates a vacuum at the top of a siphon tube. The suction draws pesticide from the tank and forces it out with the air. This type of sprayer ranges in size from hand-held (capacity 1 L) to wheelbarrow sprayers with up to 100 L capacity tanks and a long spray hose.

Motorized Sprayers

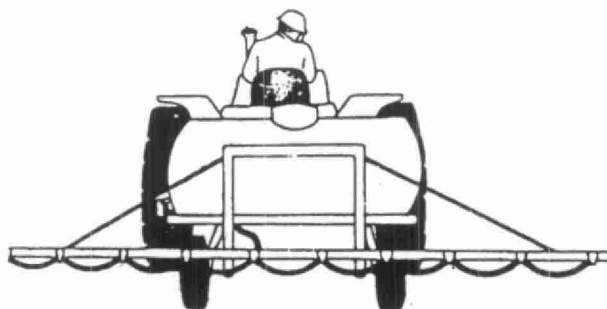
These spray units use a power-driven pump to provide pressure to the hose rather than the tank. These systems can be mounted on tractors, trucks, trailers or aircraft. They may be low-pressure or high-pressure types according to the pump and the other components included. Some examples include:

Low-pressure Boomless Sprayers

These sprayers come in a wide variety of sizes. Working pressures are usually less than 500 kPa. They may be mounted on skids for carrying in small trucks or mounted on a trailer for pulling manually or with a vehicle. They may be equipped with a hose and a handgun with an adjustable nozzle for spot treatments. They may also have a central nozzle cluster that produces a wide spray for broadcast treatments

Low-pressure Boom Sprayers

These sprayers are designed to spray pesticide solution over a large area. They are most often used in agriculture, forestry and right-of-way pest control operations. They deliver low to moderate application rates, usually 50 to 500 L/ha, at working pressures ranging from 150 to 500 kPa. The most common booms are between 6 and 10 m long and contain nozzles spaced at 50 to 100 cm intervals.

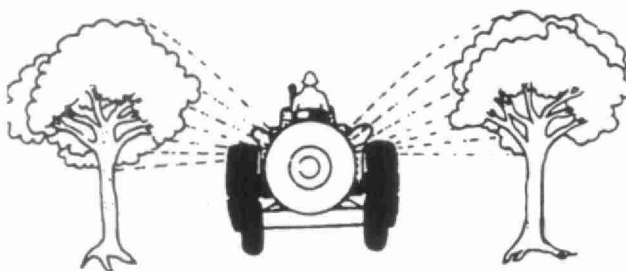


High-pressure Sprayers

These sprayers are used to spray through thick foliage, to the tops of trees, and into other areas where high-pressure is necessary to ensure complete and even spraying. Often called hydraulic sprayers, they can develop pressures up to 7,000 kPa. These units must be heavy-duty to withstand the high pressures. Such sprayers can be fitted with a boom and multiple nozzles, or a hose and single handgun nozzle for use in spraying individual trees or livestock.

Air-blast Sprayers

A combination of air and liquid is used to deliver the pesticide to the surface being treated. The pesticide is pumped through nozzles into a blast of air from a high-speed fan. The pesticide is broken into fine droplets and carried to the target. These sprayers can usually be adjusted to apply high or low volumes of spray at a wide range of pressures. Normally, the spray mixture requires mechanical agitation. Drift can be a problem with the fine spray produced from these sprayers.



Low-volume Air Sprayers (mist blowers)

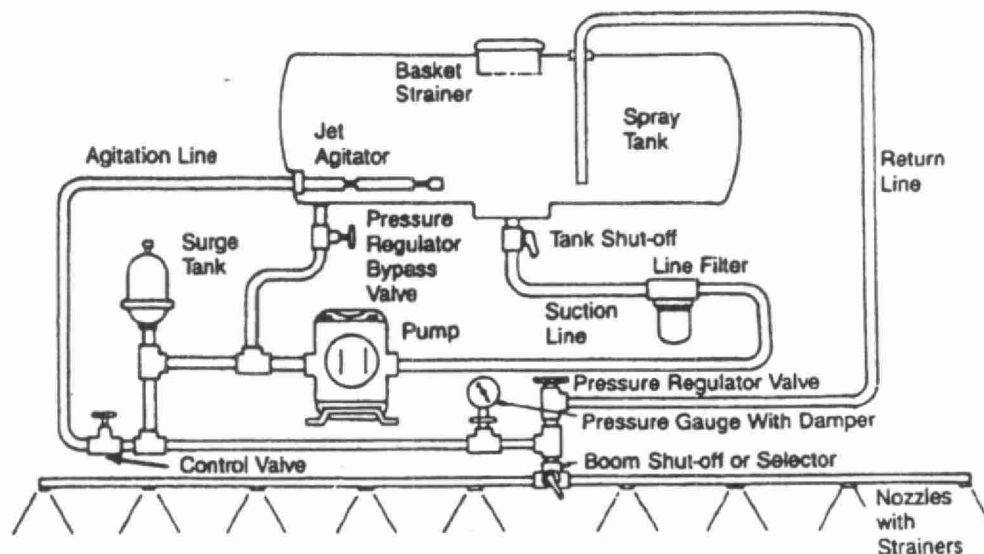
These sprayers use air at high speed to break up the liquid into droplets. They use low water volumes and operate at lower pressures than conventional air-blast sprayers.

Ultra-low Volume (ULV) Sprayers

These sprayers are used to apply special pesticide concentrates that require little or no water or other liquid carrier. The droplets are smaller but more numerous than in conventional sprays. Application rates are only 5 to 6 L/ha or less. They save time because you do not need to mix the pesticide, but the risk is greater for the applicator. Only a few pesticides are registered for ULV application.

Sprayer Parts and Spray Output

The different parts of a typical low-pressure boom spray system are illustrated below. Each of the parts is described below.



Low pressure boom spray system parts

Spray Tanks

Tanks should have a large, screened opening for easy filling and cleaning. They should have a large drain plug, located so the entire tank can be drained.

Tanks should be made of corrosion-resistant material suitable for the pesticides used. The following table shows the best material to use with pesticides that cause corrosion or deterioration.

For accurate mixing of pesticides, be sure to measure the amount of spray held by a full tank.

Choose the best spray tank for the job

Spray Tank Material	Pesticides that Cause Corrosion or Deterioration
galvanized steel	acidic formulations and pesticides such as Bordeaux mixture, carbophenothion, chlorfenvinphos, 2,4-D, dalapon, difenzoquat, endosulfan, glyphosate (may produce explosive hydrogen gas), mevinphos, paraquat, phosphamidon
aluminum	difenzoquat, paraquat, dichloro-propenes
polyethylene	EPTC, methoxychlor (also sunlight)
fibreglass	generally resistant
stainless steel	generally resistant

Pumps

The pump must be strong enough to supply the right volume of liquid to the nozzles and to the hydraulic agitator, at the same time as it maintains the desired pressure.

The pump components should be resistant to corrosion and abrasion if materials such as wettable powders are used. Gaskets, plunger caps and impellers should be resistant to the swelling and chemical breakdown caused by many liquid pesticides.

Do not use a sprayer pump at higher speeds or pressures than recommended by the manufacturer. Never run a pump dry or when the inlet or outlet is restricted. Pumps depend on the spray liquid for lubrication and cooling.

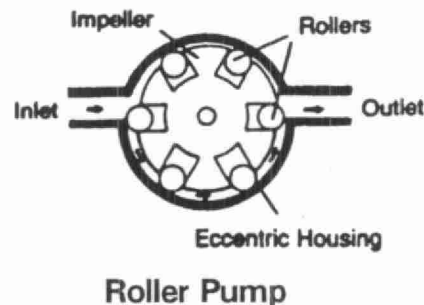
Some common types of pumps are described below.

Roller Pumps

Roller pumps are widely used and are not very expensive. They provide moderate volumes (30 L/min to 190 L/min) at low to moderately high pressures (100 to 2,000 kPa). Roller pumps are positive-displacement, self-priming pumps and are often used on low-pressure sprayers.

The rollers may be made of nylon, teflon or rubber. They wear rapidly when used for wettable powders but they can be replaced easily. To allow for wear, a pump that will be used for wettable powders should have a capacity about 50% greater than your maximum load.

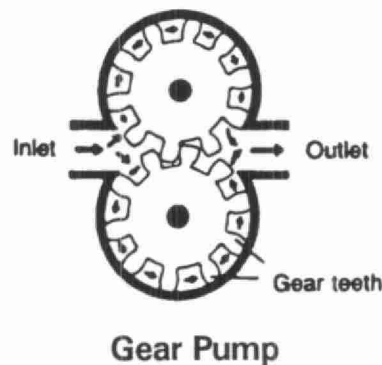
Roller pumps are best for emulsifiable concentrates, soluble powders and other non-abrasive pesticide formulations.



Gear Pumps

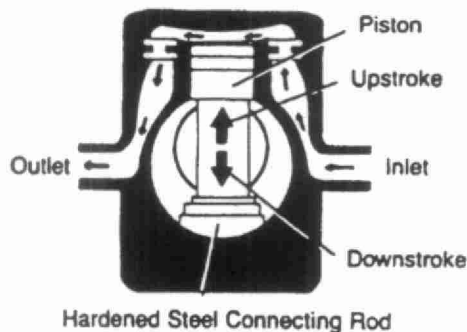
Gear pumps are used on sprayers with low operating pressures. They provide low to moderate volumes (20 to 245 L/min) at low to moderate pressures (150 to 700 kPa). Gear pumps are positive-displacement, self-priming pumps. The self-priming ability is rapidly lost as the pump wears.

These pumps are designed for oil solution formulations. They wear rapidly if suspensions of wettable powders are used. The parts are generally not replaceable. The pump is not affected by solvents, since all parts are metal.



Piston Pumps

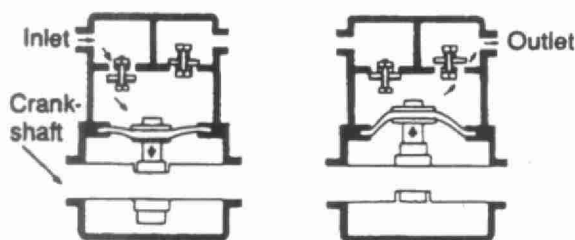
Piston pumps deliver low to medium volumes (7.5 to 225 L/min) at low to high pressures (150 to 5,500 kPa). They can be used for high-pressure sprayers or when both low and high pressures are needed. They are positive-displacement, self-priming pumps. A surge tank should be used to decrease pressure surges. Piston pumps resist abrasion well and can handle wettable powders for many years. However, you may find that maintenance costs are high.



Piston Pump

Diaphragm Pumps

Diaphragm pumps are available for low, medium and high flow, and pressure. They are excellent for use with abrasive spray mixtures. High pressure diaphragm pumps are now more popular than piston pumps. Maintenance costs are low compared to piston pumps of the same capacity. Diaphragm pumps may require a surge tank to decrease pressure surges.

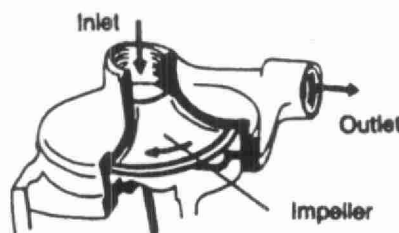


Diaphragm Pump

Centrifugal Pumps

Centrifugal pumps are used for a wide variety of spray applications, and they are not too expensive. Generally, they deliver high volumes (up to 760 L/min) at low to moderate pressures (50 to 350 kPa). Two-stage centrifugal pumps, however, can develop higher pressures (up to 1,400 kPa). They are used on agricultural sprayers, commercial spray-dip machines and other equipment.

Centrifugal pumps are not positive-displacement pumps, so pressure regulators and relief valves are only necessary if spray pressure is to be regulated. They are not self-priming and must be mounted below the tank outlet or with a built-in priming system. Centrifugal pumps work well for spraying abrasive materials because the impeller does not contact the pump housing. Many models can be repaired easily.



Centrifugal Pump

Agitators

Every sprayer must have agitation to keep the spray material well mixed. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation, the pesticide may foam and clog the pump or nozzle. The type of agitation required depends on the pesticide formulation used. There are three main types of agitation:

Mechanical Agitation

Mechanical agitation is produced by paddles attached to a shaft mounted near the bottom of the spray tank. This type of agitation assures proper mixing for all liquid spray formulations. Careful maintenance of the spray equipment is necessary to prevent premature wear of the agitator shaft bearing. Wear in this area could result in pesticide leaking through the packing or seals.

Hydraulic Agitation

Hydraulic agitation occurs when a portion of the pump output is returned to the tank. The simplest, but least effective, method is through a return line from the pressure regulator valve (return-line agitation). This type of agitation is practical only with emulsifiable and water-soluble pesticide formulations. It is not suitable for wettable powders or in tanks larger than 250 L unless a high-capacity centrifugal pump is used.

More effective agitation is provided by the high-pressure flow of surplus spray material through a separate agitator line into the spray tank. The liquid flows through jet agitators located at the bottom of the spray tank. Jet agitators must not be attached to the pressure regulator valve return line as this will cause irregular valve operation. Hydraulic agitation seldom breaks down and is less troublesome than mechanical agitation.

Air Sparging

Air sparging is agitation caused by bubbling air through the liquid. A compressor supplies air which is discharged from a sprayer tube at the bottom of the tank. As bubbles of air rise to the surface, they create turbulence which keeps the fluid well mixed.

Pipes and Hoses

Suction hoses (drawing from the tank) should be reinforced so that they will not collapse. Suction hose diameters should be at least as large as the pump intake opening. The same type of hose can be used for the bypass line.

Hoses and fittings on the pressure side of the pump must be able to handle the maximum pressure the pump can develop in order to withstand pressure surges.

The inner and outer layers of all hoses should be resistant to chemical deterioration.

Pressure Gauges

The gauge is mounted near the control valves so it is easy for the operator to see, and control, the pressure. The best place to measure pressure is at the boom.

Pressure gauges should have a pressure range which is at least twice the expected operating pressure. The gauge should have a pulsation damper to smooth pressure surges from piston pumps.

Pressure Regulator Valves

The pressure regulator controls the pressure and, indirectly, the quantity of spray material delivered by the nozzles. It also protects pump seals, hoses and other sprayer parts from damage due to excessive pressure.

The return line from the pressure regulator to the tank should be kept fully open and unrestricted. It should be large enough to carry the total pump output without any pressure build-up. The pressure range and flow capacity of the regulator must match the pressure range and the capacity of the pump. Jet agitation devices should not be attached to the return line discharge.

There are several types of pressure regulators:

Diaphragm Pressure Regulator Valves

Diaphragm pressure regulator valves open or close as the pressure changes. They divert spray back to the tank to keep the pressure constant. They regulate lower range pressures more accurately than other types of regulators. They are resistant to abrasion and may be used with wettable powders, flowables and suspensions. However, the diaphragm material must be resistant to the pesticides used.

Pressure Regulator Valves with Spring-loaded Check Valves

Pressure regulator valves with spring-loaded check valves operate like diaphragm valves and are available in many pressure ranges. At low pressures, they are less accurate than diaphragm pressure regulator valves.

Pressure Regulator Unloader Valves

Pressure regulator unloader valves work like a spring-loaded regulator valve when the sprayer is operating, but they remain open when the nozzles are shut off. They are recommended for use with high pressures (over 1,300 kPa). High pressures put a heavy strain on both the motor and pump. Each time the nozzles are shut off, a pressure surge occurs in the pressure lines. This pressure surge triggers the unloader valve, allowing the spray mixture to return, under low pressure, to the spray tank. This relieves the strain on the motor and pump when the delivery system is shut off. When the boom shut-off valve is opened, the drop in pressure in the line opens the unloader valve.

Throttling Valves

Throttling valves restrict pump output. The amount depends on how much the valve is open. These valves are used only with centrifugal pumps, whose output is very sensitive to the amount of restriction in the output line.

Pressure Regulator Bypass Valves

Some sprayers are now equipped with pressure regulator bypass valves to relieve pressure when starting the pump. As the name indicates, this valve allows the spray mixture to bypass the pressure regulator valve and return, under low pressure, to the spray tank. The bypass valve should be installed on the pressure side of the pump, with a return line to the spray tank. If a sprayer has a pressure unloader valve, a bypass valve is not required.

Filters

Filters are essential on all spray equipment. Improper filtering causes costly wear and tear on spray pumps, pressure regulators and nozzle openings. Clogged nozzles are often the result of improper filtering and cause much "down time".

Filtering devices should be used in the filler opening of the spray tank, in the suction line and in the pressure line of a sprayer system as follows:

Tank Screens

A tank screen at the filler opening may be just a funnel with a screen for small sprayers. Larger sprayers often include a filling hole screen supplied by the manufacturer. Filtering at this stage removes only large contaminants. Smaller abrasive particles pass through this screen.

Suction Line Filters

Suction line filters may be installed in two ways:

1. As a "foot screen" attached to the end of the suction line which is inserted through the top of the spray tank. This system prevents excess contaminants on the bottom of the spray tank from reaching the pump. However, the disadvantage of this system is that spray mixtures can never be entirely removed from the spray tank, except by draining. Disposing of the left-over pesticide is always a problem.

2. A better method of filtering at this stage is the use of a large area "in-line" suction filter. In this method the suction line may be attached to the bottom of the spray tank so it can be drained completely. No residue will remain to be flushed from the tank bottom. Suction line filters are usually 20 to 50 mesh*, depending on the pesticide formulation used.

Pressure Line Filters

Pressure line filters are available as "in-line" filters and nozzle screens. Pressure line filters may be used in addition to suction line filters but should never replace them. Pressure in-line filters with a 100 mesh screen are useful when very small nozzle openings are used. Nozzle screens or strainers are required for all power-operated sprayers. These screens usually vary from 50 to 200 mesh. Follow the manufacturer's recommendations.

Spray Guns

Spray guns are available in a wide variety of models and sizes. On many hand sprayers, smaller power sprayers and mist blowers, the spray gun is either built in as part of the sprayer or is supplied as standard equipment. Spray guns may consist of a shut-off valve and a nozzle (in two parts) or one adjustable unit that combines both functions.

Spray guns are made of plastic, brass, aluminum or stainless steel, or a combination of these materials. The material you choose depends on the pesticide spray mixture, the pressure, and how often the spray gun will be used.

A spray gun should be selected to match the sprayer operating pressure. Some guns are rated for pressures between 200 and 5,000 kPa. Others may be rated for different pressure ranges or for pressures less than 1,500 kPa.

Spray gun nozzles must be selected to deliver spray at the appropriate volume, angle and distance. Some nozzles are adjustable to produce different patterns ranging from a solid stream to a fine cone spray.



*mesh size refers to the number of holes per linear inch of screen

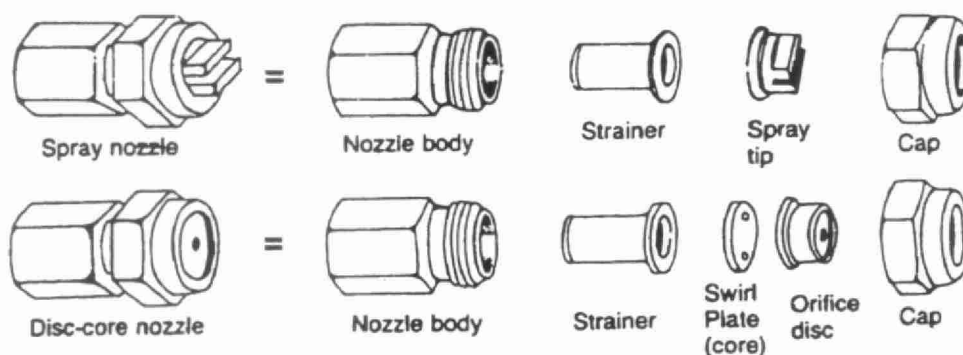
Sprayer Parts and Spray Output

Nozzles

Sprayer nozzles serve three important functions:

- they break the liquid into droplets
- they spread the droplets in a specific pattern
- they help regulate the rate of sprayer output

Most sprayers use interchangeable nozzles. There are many types of nozzles with different combinations of output capacity, spray pattern and operating pressure.



Nozzle Parts

Most nozzles are composed of four parts: the nozzle body, the strainer (screen), the tip and the cap. Some nozzles, called swirl nozzles or disc-core nozzles, include a swirl plate (core) between the strainer and an orifice disc which helps regulate droplet size. Swirl nozzles are used on air-blast sprayers.

The nozzle body holds the strainer and tip in proper position. Tips that produce different spray patterns can usually be interchanged on a nozzle body made by the same manufacturer. The cap is used to secure the strainer and the tip to the body. The nozzle screen or strainer is placed in the nozzle body to filter out debris which may clog the nozzle opening. Screens come in mesh sizes from 20 to 200. The screen must have a mesh smaller than the nozzle opening. Screens should not be finer than 50 mesh when wettable powders are used. A slotted strainer is often used in place of a screen for larger nozzle openings and cone pattern nozzles.

In some spraying operations, you may want a quick shut-off at each nozzle to prevent dripping. Special strainers equipped with check-valves are available for this purpose. A diaphragm or ball closes the nozzle opening when the pressure drops below a certain level. Diaphragm or ball check-valves are useful when turning a sprayer at the end of a row or for spot spraying near sensitive crops.

Nozzle Wear

Nozzle tips are made from a variety of materials. The choice of material depends on the abrasiveness of the spray mixture to be used. Wettable powders are more abrasive than emulsions. The nozzle materials below are listed in order of **increasing** rate of wear:

Ceramic	Slow wear
↓	↓
Hardened Stainless Steel	Slow wear
↓	↓
Thermoplastic	Slow wear
↓	↓
Stainless Steel	Slow wear
↓	↓
Nylon	Slow wear
↓	↓
Brass	Rapid wear

Hardened Stainless Steel and ceramic nozzles are expensive but they will likely outlast the rest of the sprayer. Nylon and stainless steel nozzles will give acceptable wear with most chemicals but each nozzle should be regularly checked for proper flow delivery. Brass tips are among the least expensive but the metal is soft and the tips wear very quickly.

As nozzle tips wear out, their spray pattern changes and the rate of application increases. Tests have shown that wettable powders wear some nozzle tips so quickly that the rate increases as much as 12% after spraying only 20 ha. **Replace the nozzle if the flow varies more than:**

- 10% from the manufacturer's specifications
- 5% from the sprayer's average nozzle output

Tests of different makes of nozzles have shown that some new nozzles produce unacceptable patterns, such as incorrect size and shape and uneven spray. Spray patterns can also change as nozzles wear. **Replace the nozzles if the spray patterns are incorrect.**

Nozzle Spray Patterns

Spray nozzles are described according to the shape of the spray pattern. There are seven common patterns. Each nozzle type is available in various flow capacities and spray angles and is suited to a particular type of operation.

Solid Stream Nozzles

Solid stream nozzles are used in handgun sprayers to spray directly at a target especially if it is far away. These nozzles are often used for livestock or nursery and tree pests. When you use a solid stream (or pin stream) nozzle, try to keep the pressure below 150 kPa to reduce splashing.



Solid Stream Spray

Full or Solid Cone Nozzles

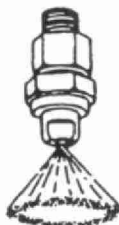
Full or solid cone nozzles are used where dense foliage requires a penetrating spray. They are most often used to apply fungicides or insecticides to the foliage of row crops where the plants must be completely covered. They are available as regular or disc-core nozzles. They are frequently used on boom drop pipes or pendants to provide coverage of both sides of leaf surfaces. The spray angle may be from 30° to 120°.



Full or Solid Cone Nozzle

Hollow Cone Nozzles

Hollow cone nozzles are used for spraying agricultural crops, especially if wettable powders, flowables and suspensions are used at higher pressures. They are available as regular or disc-core nozzles and are often used on boom drop pipes. Disc-core nozzles wear better than regular nozzles when abrasive wettable powders are used. Hollow cone nozzles generally produce a finer, more uniform spray than solid cone nozzles.



Hollow Cone Nozzle

Tapered Edge Flat Fan Nozzles

Tapered edge flat fan nozzles make a narrow oval pattern with tapered ends. They are used for broadcast herbicide and insecticide spraying at pressures between 100 and 400 kPa. This nozzle is designed to be used on a boom so the pattern can overlap 30 to 100 percent. Spacing on the boom, the spray angle and boom height determine the overlap. All of these things must be carefully adjusted when calibrating your equipment.



Tapered Edge Flat Fan Nozzle

Even Flat Fan Nozzles

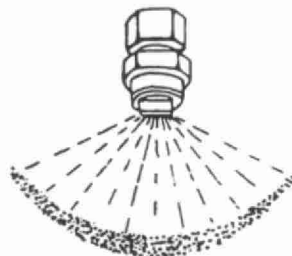
Even flat fan nozzles make a narrow oval pattern with a sharp cutoff at the edge of the pattern. They are used for band spraying. Boom height and nozzle spray angle determine the width of the band sprayed.



Even Flat Fan Nozzle

Flooding Nozzles

Flooding nozzles deliver a wide flat spray (up to 135° wide). They are usually operated at low pressures to produce large droplets. Flooding nozzles can be mounted in various positions to produce different patterns. The most uniform application occurs when the nozzle tip is mounted 45° above the horizontal. Flooding nozzles are most often used for broadcast applications. They are sometimes used alone for boomless broadcast spraying.



Flooding Nozzle

Off-centre Nozzles

Off-centre nozzles produce a wide flat spray which is off to one side of the nozzle. They produce a regular width of spray. They are often mounted on the side of trucks or short booms for spraying along roadsides or irrigation ditches.



Off-centre Nozzle

Nozzle Flow Rates

The flow rate from the nozzle depends on the size of the nozzle opening and the spray pressure. With most nozzles, flow rate increases as pressure increases. However, it takes a large increase in pressure to get a small increase in the flow rate. Pressure must be increased four times to double the flow rate.

Manufacturers supply tables that show the nozzle flow rates at various pressures. These tables are developed by measuring the flow rate of water. When other liquids are used, the flow rates will be different. This is one reason why sprayers must be calibrated for each type of liquid used.

The volume of spray to be applied per unit of area is usually shown on the label of a pesticide. For spraying agricultural crops with boom sprayers, herbicides are usually applied at 300 to 500 L/ha and fungicides and insecticides may be applied at 100 to 1,000 L/ha. Some treatments require drenches of at least 1,000 L/ha (for example - control of cabbage root maggot or potato late blight).

Various categories of spray volumes for air-blast orchard sprayers are listed in the following table. Most fruit tree pests and diseases can be controlled with low-volume air-blast sprays. High-volume air-blast spraying causes heavy spray runoff. This may be needed for control of some pests (for example bark pests such as San Jose and European fruit scales).

Categories of Spray Volumes for Air Blast Sprayers

Category	Spray Volume
Ultra-Low Volume (ULV)	5 to 6 L/ha or less
Low Volume Spraying (concentrated spraying)	Usually 550 to 850 L/ha, but may be as low as 100 L/ha. No runoff off occurs
Medium Volume Spraying	1,000 to 2,250 L/ha. Spray drop-lets flow together on the sprayed surface. Little or no runoff occurs
High Volume Spraying	2,250 to 5,500 L/ha. Heavy runoff occurs

Spray Droplet Size

A nozzle produces a range of droplet sizes from very small to large. Droplet size is measured in microns. One micron is one millionth of a metre or one thousandth of a millimetre. Average droplet sizes for various types of sprays are listed in the following table.

Typical droplet size ranges for various pesticide applications

Category	Average Droplet Size in Microns	Examples of Uses
Fog	0.1 - 50	Thermal fog for pest control in greenhouses and other buildings
Aerosol	1 - 50	Control of adult mosquitos by ground equipment, ultra-low volume applications
Mist	50 - 100	High-pressure sprays
Fine Spray	100 - 250	Cone and fan nozzles used for low-volume applications and air-blast sprayers
Medium Spray	250 - 400	Cone and fan nozzles for moderate-volume low toxicity sprays requiring good coverage
Coarse Spray	400 - 600	Cone and flood nozzles for large volume and more toxic sprays
Minimum Drift Jet Stream Nozzle Spray	600 - 900	Aerial application near sensitive areas
Low Turbulence Nozzle Spray	800 - 1000	Microfoil boom applicator for aerial spraying near sensitive areas

The number of fine droplets increases as the spray pressure is increased. At low pressures of about 135 kPa, low volume spray nozzles produce very few fine droplets (about 15% by volume). The proportion of fine droplets in the spray increases rapidly as pressure is increased over 200 kPa. At pressures of 400 kPa, the spray consists of about 75% fine droplets.

Air-blast sprayers produce a finer spray than boom sprayers for similar pressures and spray volumes. This is because the airstream which carries the spray to the target breaks up the droplets after they leave the nozzles.

Coverage will be better if you use smaller droplets. This is also the most economical use of the spray. However, spray drift is a greater problem with smaller droplets. Evaporation and the wind can easily divert the spray from the target. In order to increase coverage, it may be better to increase the volume of spray by changing nozzles, rather than increasing spray pressures to produce smaller droplets.

**Droplets per square centimetre
when 25 L is evenly distributed over 1 hectare**

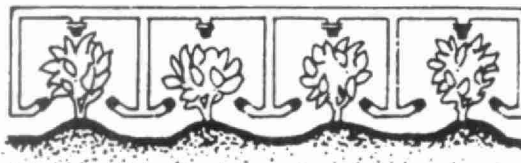
Droplet diameter in microns	Number of droplets per cm ²
50	4,000
100	500
200	60
300	20
500	4

Nozzle Pressure

Nozzle pressures should never be higher than necessary. For most applications, pressures ranging between 140 kPa and 350 kPa will produce good sized droplets.

Herbicides are generally applied within the range of 150 to 275 kPa to keep drift to a minimum. Insecticides and fungicides applied to vegetation often require higher pressures (300 to 2,000 kPa) to get thorough coverage in dense foliage.

Different nozzle arrangements may require different pressures. A drop pendant boom may require pressures of 500 to 1,000 kPa while a simple flat boom would require pressures of up to 1,700 kPa to obtain the same leaf coverage. If ball check strainers or diaphragm check valves are used, pressure must be increased.



A drop pendant spray boom that uses three nozzles for each row of plants provides better spray distribution over the plant.

Care of Spray Equipment

A sprayer should be cleaned:

- before you use it the first time
- after each day's use
- when changing pesticides
- before you store it for the off-season

Cleaning

New Sprayers

New sprayers may contain metallic chips and dirt from the manufacturing process. Remove the nozzles, flush the sprayer with clean water and clean all screens and nozzles.

After Each Day's Use

After each day's use, flush the sprayer tank, pump and hoses with clean water. Clean the filter, screens and nozzles. Drain the tank and allow it to dry. Use a toothbrush or other soft material to clean nozzle tips. Never use a piece of wire, a nail or other metal object because these will damage the opening, distort the spray pattern and increase the nozzle's output.

In Case of Spills

If a spray mixture is spilled on the machine during loading or mixing, the outside of the machine should be decontaminated immediately. Wash the contaminated area with soap (or mild detergent) and water. Rinse thoroughly with plenty of water.

Before a New Pesticide is Used and Before Off-Season Storage

A sprayer should be thoroughly cleaned before using a different pesticide and before off-season storage. Some pesticides such as 2,4-D are particularly persistent in the sprayer and must be removed completely to prevent possible crop damage during other spray operations. Follow these steps to make sure that most pesticides are removed:

1. Put on rubber gloves, boots, hat, apron and goggles to avoid contact with pesticides during cleaning operations.
2. Wash the outside of the sprayer with soap (or mild detergent) and water. Rinse with plenty of water. A steam cleaner can be used if available. Remove hard deposits with a stiff bristle brush.
3. Remove all screens and nozzle tips. Clean them in kerosene or a detergent solution using a soft brush.
4. Mix about 200 g of detergent with 100 L of water in the tank. Circulate the mixture through the bypass for 30 minutes, then flush it out through the boom. If oil is used as the pesticide carrier, you must use a petroleum based solvent (such as varsol) instead of the detergent solution.
5. Replace the screens and nozzle tips.
6. Fill the tank about one-third to one-half full of water. For each 100 litres of water in the tank, add one of the following products:
 - 1 L of household ammonia
 - 200 g of washing soda
 - 0.5 kg of Nutrasol

Circulate the mixture for five minutes, allowing a small amount to go out through the nozzles. Keep the rest of the solution in the system overnight, then run it out through the nozzles the following morning.

7. Remove the nozzles. Spray a tankful of clean water through the boom to flush the system.

8. When the pump is not in use, fill it with light oil and store it in a dry place. If the pump has grease fittings, lubricate them lightly from time to time. Over-lubrication can break seals and cause the pump to leak.
9. Remove the nozzles and screens and place them in light oil for storage.
10. Drain all parts to prevent frost damage.
11. Cover all openings so that insects, dirt and other foreign material cannot get into the system.
12. Store the sprayer, hoses and boom in a dry storage area.
13. Dispose of the rinse water from cleaning your application equipment in a way that will not contaminate the environment. See guidelines for disposal in Disposal Section.

Remember:

A number of pesticide spray mixtures will penetrate the materials used for hoses, packing and gaskets. If possible, do not use equipment which contained herbicides to apply insecticides or fungicides.

If the same equipment must be used for herbicides and other pesticides, use separate hoses as a minimum precaution against damage.

Maintenance

Proper maintenance of your equipment will save you time and money. Equipment that is in good repair helps protect the environment and your personal safety.

Good maintenance prevents problems. It reduces the hazard of accidents and break-downs during pesticide applications.

Improper maintenance results in:

- accidents
- spills
- hazards to personal safety
- contamination of the environment
- revenue loss from delays and lost time
- costs for replacement parts and labour for repairs
- crop loss

Preventative maintenance starts when you buy your equipment. Select equipment that can easily handle the job you require. Overworked equipment wears out quickly.

Pumps

Pumps must be strong enough to provide adequate volume and pressure. Always work the pump at the lowest required pressure and speed. Pressure drops may indicate:

- nothing is getting through - check suction screens and lines
- valve or piston wear - replace worn parts
- pressure regulating valve is defective - check and repair
- pump volume capacity is inadequate

Screens

Choose screens made of the proper material and with the proper mesh size for the pesticide formulation you are using. When selecting line and nozzle screens (filters, strainers) consider the particle size of the spray mixture, i.e. emulsifiable formulations, flowables, suspensions or wettable powders. The proper screens prolong the life of your pump and reduce nozzle wear.

Pressure Regulating and Unloader Valves

Pressure regulating and unloader valves must be able to handle the volume and pressure you need. Consider the port diameters and spring capacity. Never start a pump against pressure.

Agitation

Proper agitation mixes the pesticide and diluting material evenly and reduces wear on the pump. Choose a method of agitation that is right for the pesticide formulation you are using (liquids or wettable powders). When using hydraulic agitation with wettable powders, do not stop the pump if there is any spray mix in the tank. Mechanical agitation requires additional maintenance but it's the best method if you use wettable powder mixes frequently.

Hoses, Fittings and Lines

Hoses, fittings and lines must be strong enough to withstand the pressures and volumes sprayed. Excessive sediment or plugged lines may cause pressure drops. Replace worn hoses.

Spray Guns and Nozzles

Spray guns and nozzles should be appropriate for the material. Abrasive spray mixes require harder nozzle materials. Check nozzles regularly for wear. Avoid uneven application by replacing worn nozzles. Use nozzle strainers that match the size of the opening.

Other Preventative Measures

Other preventative measures include:

- **Overhaul the pump yearly in the off-season.** Keep the pump and sprayer diagram and parts list handy.
- Paint parts of the sprayer which will corrode, but do not paint the inside of the tank.
- **Clean out the sprayer after use**, especially after using wettable powders. Pesticides left in a sprayer will penetrate into hoses and gaskets, and corrode metal tanks.
- **Store unused sprayers under cover, drained and rinsed, and leave the lid off the spray tank.**
- Use gaskets and washers of material such as teflon which will not deteriorate from pesticide mixtures.
- **Keep spare parts in stock.**

Aerosol Generators and Foggers

Aerosol generators convert special formulations into very small, fine droplets which appear as a fog or mist.

Some aerosol generators, known as thermal foggers, use heat to vaporize a special oil formulation of a pesticide. As the pesticide vapour is released into the cooler air, it condenses into very fine droplets, producing a fog. Other aerosol generators (cold foggers) break the pesticide into aerosols by using rapidly spinning discs, extremely fine nozzles and high pressure (atomizing nozzles) or strong blasts of air.

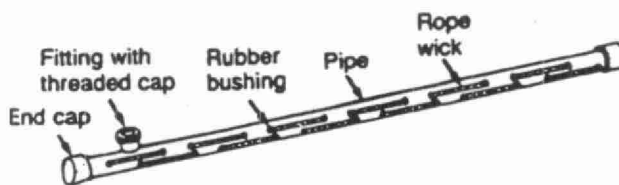
This specialized equipment is often used in greenhouses, barns and warehouses. It may also be used in outdoor recreation areas to control biting flies and mosquitos. Outdoor use of aerosols is limited because the fog quickly drifts from the target area.

Control of pests does not last long with this method, but people can re-enter an enclosed space safely soon after it is ventilated. Pesticides used in aerosol generators must be registered for that use. The operator, bystanders and animals must be kept out of the fog or mist.

Wick Applicators

Wick applicators are used to selectively apply liquid herbicide by wiping it onto plants. Wicks are made of rope or absorbent pads and are kept wet by soaking part of the material in a concentrated herbicide mixture. For example, in one type of wick applicator, the herbicide solution is poured into a length of pipe and seeps out through pieces of rope. The herbicide can be wiped selectively onto weeds growing above crop seedlings or between crop rows.

Applicators often build their own wick equipment to fit their needs. Pumps, control devices and nozzles are generally not needed and tanks are quite small because of the small amount of herbicide applied. Wick applicators can be useful where selective weed control is required and no drift can be tolerated.



Wick Applicator

Equipment for Application of Special Pesticide Formulations

Dust Applications

Dust formulations may be applied by small or large dusters that are hand-operated or motorized. Power dusters are used for large areas where deep penetration is required. They are powered by electricity or gasoline and consist of a motor, dust hopper and radial fan. Motorized backpack sprayers (mist blowers) sometimes feature an optional tank for the application of dusts.

In selecting a power duster, look for a unit which is easy to clean. It should give a uniform application rate as the hopper is emptied. The dust cloud should be directed away from the user.

Because air is the carrier for all dust formulations, drift is a major problem. Dust applications are, therefore, not recommended for large-scale operations outdoors. In agriculture, dust applications are mostly used for small spot treatments. The residue from a dust application is unsightly on ornamental crops and plants and may be dangerous on edible crops.

Granular Applicators

Granular formulations are often used for large-scale soil applications where residual action is needed. Unlike spray and dust applications, granular formulations do not produce drift or unsightly residues.

Granular applications may be described as:

- broadcast - even distribution over an entire area
- spot treatment - hand application, furrow application or side-dressing
- soil incorporation - drilling or soil injection.

Mechanical applicators distribute granules by means of forced air, spinning or whirling discs (fertilizer spreaders), multiple gravity-feed outlets (lawn spreaders, seed drills), soil injectors (furrow treatments) or ram-air (aircraft application). A hand shaker may be used for small spot treatments.

Good granular applicators have mechanical agitation over the outlet holes. This prevents clogging and helps keep the flow rate constant. Applicators should stop dispensing pesticide when forward motion stops, even if the outlets are still open.

The speed of the application depends on the ground conditions- don't go too fast. Bouncing equipment will cause the application rate to vary.

Band applicators must be checked frequently to see that the band width stays the same. For example, if the applicator wheels sink into soft soil, the band width may change.

Granular applicators have some limitations. For example, you must calibrate for each different granular formulation you use. Also, the spinning disc applicators often distribute the pesticide unevenly on sloping ground.

Soil Fumigation Equipment

The equipment needed for applying soil fumigants depends on the kind of fumigant you use. There are two types of fumigants:

- low-pressure (low volatility) liquid fumigants (dichloropropenes and metam-sodium)
- the highly volatile fumigants (methyl bromide) which remain liquid only under pressure.

Low-Pressure Liquid Fumigators

There are two systems for applying low-pressure fumigants - pressure-fed or gravity-flow.

Pressure-fed applicators have a pump and metering device. They are similar to a low-pressure sprayer. They deliver fumigant under pressure to the nozzle openings.

In **gravity-flow applicators**, the size of the nozzle opening and the pressure created by gravity regulates the output of fumigant. A constant speed is needed to keep the delivery rate even. Most applicators have a constant head gravity-flow device to keep the pressure at the opening(s) even as the container of fumigant empties. Needle valves, orifice plates or discs, and capillary tubes are used to adjust the flow rate.

Low-pressure fumigators usually use soil or water to keep the fumigant from vaporizing and dispersing too quickly. They may use soil injection, soil incorporation and drenching or flooding.

- **Soil injection** places the fumigant into the soil (usually down 15 cm or more). The area is covered with more soil to seal in the fumigant. A number of tools may be used to do this, including chisel cultivators, sweep cultivator shovels, planter shoes and ploughs.
- **Soil incorporation** is used when applying low-volatility fumigants. The fumigant is usually sprayed onto the soil surface. The area is immediately cultivated (usually to a depth of 15 cm or less) and then compacted with a drag, float or cultipacker. Power-driven rotary cultivators are also used.
- **Drenching or flooding** uses water as a sealant. The fumigant may be applied in water (for example, with a sprinkling can or irrigation equipment). Another method is to apply the fumigant first, by spraying the soil surface, then flooding the area with water. Up to 10 cm of wetted soil may be required to seal the area, depending on the volatility of the fumigant.

High-Pressure Fumigators

If you use a highly-volatile fumigant you must seal the soil tightly with tarps, plastic film or a similar cover. Vapour-proof tarps can be used in two ways:

- Tarps are supported off the ground, then sealed around the edges and the fumigant is introduced under the tarp.
- Tarps are applied to soil by the chisel applicator immediately after the fumigant is injected.

Highly-volatile fumigants must be handled in pressurized containers or tanks. The pressure in the tank maintains the pressure at the nozzle openings. The tank is either pre-charged with enough pressure to empty its contents, or pressurized gas is fed into the tank during application to displace the fumigant. A pressure regulator maintains uniform pressure in the system. The fumigant must be under enough pressure to keep it liquid in the tank, pressure lines, manifold and metering devices. As the fumigant is discharged from the nozzles, it becomes a gas.

**Be extremely careful when working with fumigants.
Fumigant gases are highly toxic.**

Review Questions

1. Match the following word with the right definition.

Hose-end sprayers	_____	a) suction draws a fixed rate of pesticide from a small tank, to mix with water flowing through a hose
Compressed air sprayers	_____	b) apply pesticide concentrates with little or no water or other liquid carrier
Low-pressure boom sprayers	_____	c) a combination of air (from a high speed fan) and liquid is used to deliver the pesticide to the surface being treated.
Air-blast sprayers	_____	d) operate under pressure, usually supplied by a manual pump which fits into the top of the spray tank
Ultra-low volume sprayers	_____	e) designed to distribute pesticide solutions over large areas at a working pressure of 150 to 500 kPa

2. Spray tanks made of polyethylene and galvanized steel are generally resistant to pesticides that cause corrosion or deterioration.

TRUE

FALSE

3. An agitator on a sprayer is necessary:

- a) because it causes the pesticide solution to foam and increase in volume
- b) only when using emulsifiable concentrate formulations
- c) to keep the spray solution evenly mixed
- d) in case the application is delayed. Mixed tank solutions will remain unaffected for several hours if there is continuous agitation
- e) none of the above

4. A _____ is mounted near the sprayer controls so the operator can see and control the pressure easily.
5. Pressure regulator valves:
- a) are not necessary if the sprayer is equipped with a pressure gauge
 - b) are only recommended for high pressure sprayers (over 1,300 kPa) to relieve the strain on the motor and pump
 - c) may only be used with certain pesticide formulations
 - d) control the pressure and indirectly the quantity of spray material delivered by the nozzles
 - e) both b) and c) are correct
6. Filters are essential on all spray equipment. Name the three areas of a sprayer system where filtering devices should be used.
- 1. _____
 - 2. _____
 - 3. _____
7. As nozzle tips wear out, their spray pattern changes and rate of application increases. If the flow from an individual nozzle varies by 5% above or below the average nozzle output, it should be replaced.
- TRUE** **FALSE**
8. Once you have finished spraying for the season, it is important to clean and store your sprayer. Describe how to properly clean and store nozzles and screens while your sprayer is not in use.

9. Wick applicators are useful where selective weed control is required and no drift can be tolerated.

TRUE

FALSE

10. One advantage to using a granular applicator is that, unlike a sprayer, granular applicators do not need to be calibrated for each different granular formulation.

TRUE

FALSE

11. Why is it important to be extremely careful when working with fumigants?



Calibration of Application Equipment

What is Calibration?

Calibration is a test measurement of the output of your application equipment under typical operating conditions.

Calibration should be done:

- before you use new application equipment
- when you change the pesticide product or dilution
- at regular intervals to determine whether wear has changed the output of application equipment. For example:
 - Sprayers with brass nozzles should be recalibrated after each 25 hours of use.
 - Sprayers with stainless steel nozzles should be recalibrated after each 50 hours of use.
 - Calibration should be done more frequently when you use abrasive wettable powders.

Why Calibrate?

It is very important to take time to calibrate your application equipment. You must make sure that:

- the pesticide is being applied at the application rate recommended on the label. This is determined by measuring the output of the sprayer or applicator.
- the pesticide is being applied evenly over the whole field. This is determined by measuring the output from the nozzles or hopper (for granular pesticides).

Output

What output is required?

The first step is to find out what output is required for the pesticide you are using.

For granular pesticides, the applicator output is given on the label as weight per unit of area (for example - 45 kilograms per hectare - 45 kg/ha).

For liquid pesticides, the sprayer output is the amount of spray applied per unit of area. Some labels tell you exactly what the sprayer output should be - for example: "Apply 5 L of pesticide in 600 L of water per hectare". The sprayer output should be 600 L of water per hectare.

Some labels will not give you the exact output. For example, the label may say, "Apply 2 L of pesticide in up to 500 L of water per hectare", or "in 200 to 600 L of water per hectare".

If the label does not tell you the exact output, you must select the output that is right for the treatment. If you are using liquid spray equipment, keep the following things in mind:

- **the coverage required** - Spraying to runoff requires a greater sprayer output than spraying only to wet the surface.
- **the surface to be treated** - Dense foliage or porous surfaces may require a greater sprayer output.
- **droplet size** - A high sprayer output generally means a coarse spray can be used.
- **mixing requirements** - A high sprayer output may require large spray tanks or frequent stops to fill your tank.

Here are some general guidelines:

- Herbicides are generally sprayed in 300 to 600 L of water per hectare.
- Insecticides and fungicides are generally sprayed in 1,000 L of water per hectare.
- Aerial applications may use lower sprayer output, for example, from 25 to 200 litres per hectare.

Factors that Affect Output

The three factors which determine the output of pesticides from all types of application equipment are: size of the openings, travel speed, and pressure.

1. Size of the openings

For granular applicators, the operator instructions tell you what setting to use to get a specific output. They will also tell you the speed you should drive to spread it evenly.

For liquid spray equipment, the output depends on the size of the nozzle opening. Nozzle manufacturers usually provide charts which show the combination of nozzle size and pressure that will give you a specific nozzle output (L/min). However, you should check the output of each nozzle in the field when you calibrate your equipment. Most charts of nozzle output are based on tests using water, not spray mix. Wear on the nozzle opening will also affect the nozzle output.

2. **Travel Speed** is the speed that you drive the equipment. The faster you go, the lower the output will be. This is called an inverse relationship. For example - If you double the speed, you will cut the output of your application equipment in half.

Motorized equipment must be operated at a speed suited to the job. The usual speed is between 3 and 12 km/h. If the speed is too fast, the pesticide will drift. If the speed is too slow, it may take too long to apply the product.

Tractor or truck speedometers are not always accurate in the field. It may be necessary to check your driving speed by timing how long it takes you to drive over a measured distance in the field. Make a note of the gear, and throttle setting or rpm, so you will know what settings to use when you apply the pesticide.

3. Pressure (force)

For granular equipment no force is needed to push the granules through the openings. Output is determined by the opening size and the speed only.

For liquid spray equipment force is generated by a pump and is measured in kilopascals (kPa). The more force that is applied to the liquid, the higher the output will be. Reduce the force (pressure) and you reduce the output. **Changing pressure changes droplet size.**

The manufacturers of application equipment have developed tables that tell you how these factors interact to give a specific output. However, you should not depend on a manufacturer's chart to be sure of your output. You must test your equipment in the field. Even a small change in any of these factors will affect the amount of pesticide that is applied.

Always test your equipment in the field to be sure of your output for the speed, pressure, and nozzle or gauge setting you are using.

This test is the calibration of your equipment.

How to Calibrate Application Equipment

The following sections tell you how to calibrate the following applicators:

- hand held and backpack sprayers
- motorized pressure sprayers
- granular application equipment

For information on how to adjust Air Blast Orchard sprayers, refer to OMAFRA Publication 360 - **Fruit Production Recommendations**.

Hand Held/ Backpack Sprayers

Often a grower needs to treat a small area of his crop with a pesticide - a "spot" treatment. A small garden sprayer or compressed air sprayer can be used. Calibration of these portable sprayers is used to check the spray pattern and the sprayer output.

Calibrating the sprayer

1. **Measure out an area that is 100 m².**
(for example 10 m x 10 m, or 25 m x 4 m)
2. **Fill the spray tank with water.** Mark the level on a measuring stick. Pump to the pressure which will be used during the pesticide application.
3. **Spray the water over the 100 m² area.** Walk at a steady pace, taking care to apply it as evenly as possible, just as you would when applying pesticide.

4. **Measure the amount of water needed to refill the spray tank to the mark on the measuring stick.** This amount will be the sprayer output per 100 m².

If the spray tank is not large enough to cover an area of 100 m², use the following calibration procedure:

1. **Measure the amount of water needed to fill the sprayer.** Pump to the pressure you will use during the pesticide application.
2. **Spray an area as evenly as possible, walking at a steady pace.** Spray until the tank is empty.
3. **Measure the number of square metres covered.** For example,
an area 6 m x 10 m = 60 m²
an area 8 m x 3 m = 24 m²
4. **Use the recommended amount of pesticide for this number of square metres each time you fill the tank.**

To convert the application rate of any pesticide to the amount required for a small area, follow this guide:

- 1 kg per hectare is equal to 10 grams per 100 square metres.
- For liquid measure, 100 litres per hectare is equal to 1 litre per 100 square metres. (One level tablespoon equals 15 mL.)

Motorized Pressure Sprayers

All motorized pressure sprayers require similar adjustments and calibration. You must first determine the nozzle output before you can calibrate a motorized pressure sprayer.

Nozzle Output

Nozzle output depends on the size of the nozzle opening and pump pressure.

Nozzle manufacturers usually provide detailed charts to help you choose the right nozzle tip. Some charts show the nozzle tip that will produce a certain sprayer output (L/ha) for a given travel speed (km/hr), pressure (kPa), and nozzle spacing. This kind of chart is shown on page 206.

Choose nozzles which are as close as possible to the output, travel speed, pressure, and nozzle spacing required for your spraying job.

How to Calculate Nozzle Output

Some nozzle charts only list the output rates for a nozzle at a given pressure. You must calculate the nozzle output (L/min) which will give the correct sprayer output (L/ha), taking into account your travel speed and nozzle spacing. To calculate the nozzle output, you can use the formula shown below.

$$\text{Nozzle Output (L/min)} = \frac{\text{sprayer output (L/ha)} \times \frac{\text{speed (km/hr)}}{600^*} \times \text{nozzle spacing (m)}}{1}$$

Note:

1. The recommended sprayer output (L/ha) can be found on the label, or from the guide on page 202.
2. You determine the speed based on the travel speed test described on page 203.
3. If the nozzle spacing is less than 1 metre, it must be shown as a decimal.
4. The number 600 is always the same. It allows you to calculate the nozzle output in litres per minute from a sprayer output in litres per hectare, or speed in kilometres per hour, or the nozzle spacing in metres. See the note at the bottom of the page for more details.

Example:

What should the nozzle output (L/min) be in order to apply a total sprayer output of 110 L/ha, when the travel speed is 10 km/hr and the nozzle spacing is 50 cm?

$$\text{Answer} = \frac{110 \text{ L/ha} \times 10 \text{ km/hr} \times 0.5 \text{ m}}{600^*}$$

$$\text{Nozzle Output} = 0.92 \text{ L/min}$$

Check this nozzle output against the chart. Then choose the nozzle tips with the closest output.

*Note: 600 is a constant. It represents the following calculation.

$$\frac{1 \text{ ha}}{10,000 \text{ m}} \times \frac{1,000 \text{ m}}{1 \text{ km}} \times \frac{1 \text{ hr}}{60 \text{ min}} = \frac{1}{600}$$

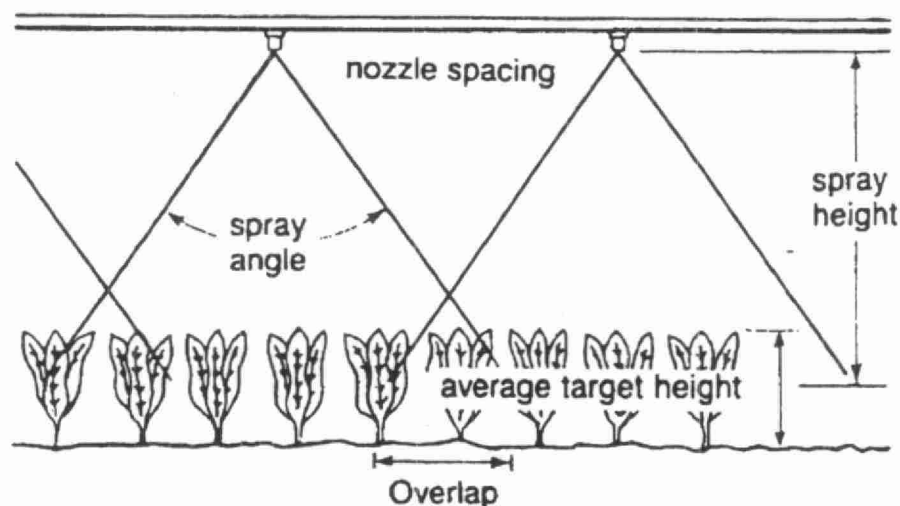
How to Adjust the Nozzles and Boom

Install the nozzle tips on a boom using the spacing and boom height recommended by the manufacturer.

Overlapping Nozzles

Nozzle tips should be lined up carefully. If they are not set up properly you may get uneven coverage. The boom must also be level. If not, the spray pattern will be uneven.

When using overlapping nozzles on a boom, the manufacturers often recommend a 50% overlap of spray from each flat fan nozzle. The height of the boom will change the amount of overlap. Set the boom height at the height recommended by the nozzle manufacturer, then adjust it during calibration if necessary.



Wide Angle Nozzles

Some farmers are beginning to use wide angle nozzles (110°) with 100% overlap of spray. This complete overlap spreads the spray more evenly. Small changes in the boom height during application have little effect. Nozzles with a wide spray angle also allow you to use a lower boom height, and reduce the amount of spray drift.

If you increase the line pressure, it will also increase the spray angle of some nozzles. This makes it necessary to adjust the boom height.

It may be necessary to adjust the boom height from time to time if the plants you are spraying vary in height.

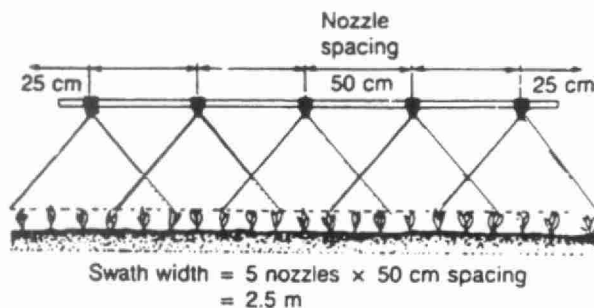
Chart of sprayer output for various fan nozzle types, pressures, and travel speeds

Delavan Nozzles	Teejet Nozzles		Pressure (kPa)	Output (L/min)	Sprayer Output (L/ha) at			
	65° & 80°	65° 80°			6 km/h	8 km/h	10 km/h	12 km/h
LF-0.67	650067 & 800067		200	0.22	43	32	26	22
			275	0.25	51	38	31	25
LF-1	6501 & 8001		200	0.32	64	48	39	32
			275	0.38	76	57	45	38
LF-1.5	65015 & 80015		200	0.48	97	73	58	48
			275	0.57	113	85	68	57
LF-2	6502 & 8002		200	0.64	129	97	77	64
			275	0.76	151	113	91	76
LF-3	6503 & 8003		200	0.97	193	145	116	97
			275	1.13	227	170	136	113
LF-4	6504 & 8004		200	1.29	258	193	155	129
			275	1.51	302	227	181	151

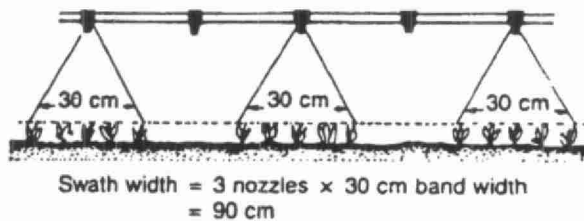
Note: These figures are based on nozzles spaced at 50 cm.

How to Measure the Spray Width

The spray width of a boom sprayer with overlapping spray patterns is the width between nozzles (or drop pipes) multiplied by the number of nozzles. Note that the spray width will be wider than the total distance between the outermost nozzles.



Broadcast Spray

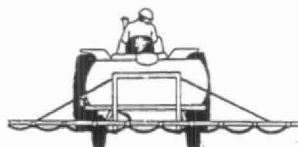


Band Spray

On a boom sprayer used for band applications, the boom height affects the width of the band the nozzle sprays. The boom height must be adjusted to get the band width needed for the angle of nozzle selected. The spray width of a band sprayer is the sum of the widths that each nozzle sprays.

On a boomless sprayer, nozzle selection charts often show the spray width produced by nozzles when they are set at a certain height. An overlap percentage may also be recommended. In this case, the spray width includes half the width of overlap between nozzles.

Calibrating the Sprayer



After the sprayer is set up, it should be calibrated (or tested) to make sure that it is working properly under field conditions.

It is not necessary to spray over a whole hectare or acre to calibrate a sprayer. It is possible to calibrate a sprayer by knowing a few facts and doing some figuring.

One method of calibration is outlined below. This method gives you sprayer output in litres per hectare. With this method you need to know three things:

- time to travel 50 metres
- average nozzle output measured in millilitres
- nozzle spacing in metres.

1. Measure the Time

- Place 2 stakes 50 metres apart in the field.
- Select the gear in which you will spray.
- Drive the distance between the stakes three times, timing each pass. Each time, make sure the tractor is at the desired spraying speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
- Take the average time of three passes.

2. Measure the Average Nozzle Output

- Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
- Adjust the pressure regulator to the desired working pressure with full flow to the boom.
- Collect the output from each nozzle for the average length of time needed to travel the 50 metres in the test run. **If any nozzle is more than 5% above or below the average output, it should be cleaned or replaced.**
- Add up all of the nozzle outputs and divide by the number of nozzles. This will give you the average output per nozzle. Make sure your measurement is in **millilitres**.

3. Measure the Nozzle Spacing in Metres

4. Use the Following Formula to Determine the Sprayer Output:

$$\text{sprayer output (litres/hectare)} = \frac{\text{average nozzle output (mL)}}{\text{nozzle spacing (m)}} \times 0.2$$

Growers who prefer to measure in litres/acre or gallons/acre, can use the following guide to convert:

- litres per hectare x 0.4 = litres per acre
- litres per hectare x 0.09 = Imperial gallons per acre
- litres per hectare x 0.11 = U.S. gallons per acre

How to Adjust the Sprayer Output

If calibration shows that your equipment is not delivering the output you want, you should adjust the sprayer and test it again. You can adjust the sprayer output in one of three ways:

- **Change the pump pressure.** Lower pressure means less spray delivered - higher pressure means more spray delivered. Make only minor adjustments in pressure because any adjustments will change the size of the spray droplets, and the nozzle pattern.
- **Change the nozzle tips.** Changing the nozzle tips is the recommended way to make a large adjustment to sprayer output.
- **Change the travel speed.** Slower speed means more spray delivered per unit of area. Faster speed means less spray delivered. This is an easy way to make small adjustments to sprayer output.

Use the following formula:

$$\text{Required Speed} = \frac{\text{present speed (km/hr)} \times \text{present sprayer output (L/ha)}}{\text{desired sprayer output (L/ha)}}$$

Granular Application Equipment

Granular application equipment may use gravity feed, whirling discs (spinners) or air-blast methods to apply the granules.

The applicator output per hectare (kg/ha) depends on the travel speed of the equipment, the nozzle spacing and the output of granules per minute (kg/min).

The output of your equipment per minute depends on the size of the adjustable hopper openings, the size, weight, and shape of the granules and the roughness of the field. Calibrate your equipment for each batch of product used and for new field conditions.

Follow the manufacturer's instructions in the equipment manual for the first settings. Use the recommended output settings for the type of granules you are using. Use the recommended speed unless the surface is soft, muddy or uneven, then use a lower speed.

Calibrating Granular Application Equipment

1. Check the width of the application and application pattern.

Fill the hopper with some granules. Drive a short distance at the desired speed. Measure the width of the application area and check that the granules are distributed evenly along the area. If the granule pattern is uneven, you may need to adjust the speed of the spinner, or the spot on the spinner where the granules land.

2. Determine the applicator output by measuring the actual amount applied to a measured test area.

- Fill the hopper half-full of granules.
- Mark out a distance of 200 m or more.
- Collect the material discharged from the spreader in a bag or box while driving the tractor over the 200 m distance.
- Weigh the granules discharged into the container and calculate the applicator output per hectare by the following formula:

$$\begin{array}{lcl} \text{Output} & & \text{amount applied to} \\ \text{(kg/ha)} & = & \text{test area (kg)} \quad \times \quad 10,000 \text{ m}^2/\text{ha} \\ \text{per hectare} & & \text{distance travelled (m)} \quad \times \quad \text{width of applicator (m)} \end{array}$$

3. Adjust the applicator output if the calibration shows that the equipment is not delivering the required application rate.

To change the applicator output, you can:

- Adjust the granule output setting on the spreader, then do the calibration again.
- Adjust the travel speed.

Use the following formula to calculate the speed required to obtain the desired output:

$$\begin{array}{lcl} \text{Required} & & \text{present speed} \quad \quad \quad \text{present applicator output} \\ \text{Speed} & = & \text{(km/hr)} \quad \quad \times \quad \quad \text{(kg/ha)} \\ \text{(km/hr)} & & \text{desired applicator output (kg/ha)} \end{array}$$

Review Questions

1. List the steps required to calibrate a backpack sprayer.

2. Use the sprayer output table to answer the following question.

If a grower wanted to apply a sprayer output of around 150 L/ha while driving at 6 km/h, what nozzle should he select?

3. The output of a boom sprayer can be increased by:

- a) increasing the pressure
- b) increasing the pump's rpm's
- c) selecting nozzles with larger openings
- d) all of the above
- e) only a) and c)

How Well Pesticides Work

How well a pesticide works depends upon weather conditions and the physical environment. The pesticide must arrive at the target in a way that will effectively control the pest. Plant stress, water quality, and drift, are some of the factors that determine how well a pesticide works.

Plant Stress

Some pesticides, such as Roundup, must enter the plant tissue to be effective. Mature plants and plants under moisture stress may have a tougher cuticle and the chemical cannot penetrate the tissue. Spray generally should be applied to actively growing plants. **Read the label for the best time of plant growth to apply chemicals.**

Water Quality

The water that is used to mix with the pesticide may affect pesticide performance. It should be at the recommended pH and temperature, as stated on the pesticide label and should also be free of sediment or organic matter.

pH of Spray Water

The pH of water measures how acidic or alkaline the water is. pH can range from 1 (extremely acidic) to 14 (extremely alkaline).

below 7	7	above 7
acidic	neutral	alkaline
pH scale		

The performance of pesticides can be affected by pH. Each pesticide is different. Most pesticides are not affected by acidic water. However, alkaline water can destroy some pesticides because they begin to break down when added to alkaline water. Many water sources in Ontario have a high (alkaline) pH. If the breakdown is significant this may result in poor pest control. Water with a pH of 7.5 may be alkaline enough to affect the stability of some pesticides.

Sediment in Spray Water

Unwanted sediment will:

- plug screens
- wear down nozzles and pumps
- alter the effectiveness of the chemical. Some pesticides are adsorbed by the soil and organic matter in the water. If adsorbed the pesticide is not available to control the pest.

Drift

Pesticides may move from the target site because of vapour drift or spray drift. Drift reduces the effectiveness of the pesticide in the targeted area and may have a harmful effect on nearby plant or animal life.

Spray Drift occurs when the wind is strong enough to pick up and carry fine spray droplets. Small spray particles drift more easily than large particles. Fine spray droplets are produced by high pressure spraying. Granular and powder formulations will also drift.

Vapour Drift is the movement of pesticide vapours. Some pesticides are volatile and will turn to vapour after a period of time in the air or on the plant. This vapour will drift to other areas and may cause serious problems where susceptible plants are nearby.

When spraying a field, the applicator must be aware of susceptible plants growing in the area which may be affected by the spray being used. For example, 2,4-D type herbicides may be used on a crop to control broadleaf weeds, but this same chemical may also kill fruit or vegetable crops in the area if it is allowed to drift. This may result in legal action from your neighbour.

Water Contamination

Pesticides can drift to ponds, streams or other water bodies. The spray and vapour drift can:

- be toxic to fish, wildlife, domestic animals or humans
- make the water undrinkable
- make the water unsuitable for irrigation

Factors Affecting Drift

Wind

Spray operations should be carried out when winds are below 10 km/hr. Wind speeds greater than 10 km/hr may carry some of the spray away from the target area. Do not spray under still air conditions. Some air movement is needed for proper spray coverage. If you notice that drift due to wind is occurring, stop spraying until the wind subsides. The best time of day to spray is usually early morning or evening.

Temperature

Temperature will affect the effectiveness of some pesticides. You should check label directions. On a very warm day, spray droplets may evaporate into the air and therefore increase drift potential. If the ground is warmer than the surrounding air, the rising air may prevent spray droplets from touching the ground and increase the potential for off target drift.

A **temperature inversion** is when air at ground level is cooler and more stable than the air above ground level. Very fine droplets remain suspended for long periods of time and are more likely to drift away from the intended target during a temperature inversion.

Humidity

Low humidity will increase the chance of spray droplet evaporation and therefore drift. Larger droplet size will reduce the rate of evaporation. **Always read the label for directions as to droplet size, spray pressure and environmental conditions in which the spray must be applied.**

Before starting your spray program, you should listen to the current weather predictions. The weather conditions at time of application and immediately after application have a direct effect on how effective your chemicals will be.

Volatility

Some pesticides change more quickly into vapour than others. They have a high volatility. To reduce volatilization, avoid spraying when temperatures are high, and use low volatility formulations. For instance, 2,4-D is available in amine or ester formulations. The ester formulations are volatile, so only the amines should be used near susceptible crops.

Droplet Size

Large droplets are heavier and will land on the target area more quickly. Fine droplets are susceptible to drifting and evaporation. Droplet size can be altered by changing nozzle size or sprayer pressure.

**Distance
Between Nozzle
and Target**

Lowering the boom of the sprayer reduces the distance that the spray droplets must travel. However, care should be taken to maintain a stable boom height to ensure uniform coverage. Also, tilting the nozzles forward or using wide angle nozzles will reduce drift while maintaining uniform application.

Adjuvants

Some adjuvants can control spray droplet sizes and ensure accurate flight of the droplets to target areas. Only use adjuvants as drift reduction agents if recommended on the label.

Review Questions

1. List 3 factors that contribute to drift.

1. _____
2. _____
3. _____

2. The pH of water is the degree to which water is alkaline or acidic.

TRUE

FALSE

Applying the Right Amount of Pesticide

For the most effective pest control, you must:

- choose the right pesticide
- apply it at the right time
- apply the right amount of pesticide.

The amount of pesticide applied per unit of area or per plant is known as the **pesticide rate**.

The label on each pesticide product tells you the pesticide rate for specific pests on specific crops (livestock).

Remember that a pesticide label is a legal document. You must follow the directions exactly.

- You must use the product **only** for the pests and the crops (livestock) listed on the label.
- You must use the pesticide rate shown on the label.

Why worry about the amount of pesticide you use?

If you use too much pesticide, it may damage your crops, or cause damage to other plants or animals.

The extra pesticide may stay on the plants as residue, or run off into the soil. If you use too little pesticide, the treatment may not be effective.

Pesticide Rate

Once you have decided on the pesticide, then read the label carefully to find out what the correct pesticide rate is.

Sprayer Output

Be sure that your application equipment will do the job correctly. It must apply the pesticide evenly over the whole crop at the pesticide rate shown on the label. This is called the **output** of the application equipment (see Section 20).

Calculate How Much Pesticide to Use

The next step is to calculate how much pesticide to use. You need to know how much pesticide and carrier to add to each tank or hopper, and the amount of pesticide you need for the whole area.

This section reviews the different ways that pesticide rate is described, and tells you how to calculate the amount of pesticide and spray mix you need.

You will learn how to answer the following questions:

1. How large is the treatment area?
2. What is the pesticide rate?
3. How much pesticide should you buy?
4. How much **area** does one **full** tank cover?
5. How much **pesticide** should you add to a **full** tank?
6. How much area is left to be sprayed?
7. How much **pesticide** should you add to a **part** tank?
8. How much **spray mix** is needed for the **part** tank?

This section will show you how to do the mathematics to answer these questions. We will go step by step through each one of the examples to show you how to make the calculations. A pocket calculator will make it easier and faster.

Remember that you also need to know the sprayer output of the application equipment. Review the "Application Equipment" section if you have any questions.

How to Calculate the Amount of Pesticide You Need

1. How large is the treatment area?

- Multiply the length of the field times the width.
- If you are using metres, divide this number by 10,000 - the number of m² in a hectare. This gives you the number of hectares (ha).

$$\text{ha} = \frac{\text{length (m)} \times \text{width (m)}}{10,000 \text{ m}^2/\text{ha}}$$

- If you are using feet, divide the number by 43,560 - the number of ft² in an acre. This gives you the number of acres.

$$\text{acres} = \frac{\text{length (ft)} \times \text{width (ft)}}{43,560 \text{ ft}^2/\text{acre}}$$

2. What is the pesticide rate?

In Canada, labels give the pesticide rate in litres per hectare (L/ha), or kilograms per hectare (kg/ha).

- **If you measure the area of your fields in hectares**, you can use the pesticide rate shown on the label.
- **If you measure the area of your fields in acres**, you will have to change the pesticide rate shown on the label from litres (or kilograms) per hectare to litres (or kilograms) per acre. You can do this by multiplying the label rate by 0.4. This changes the label rate to litres (or kilograms) per acre.

$$\text{label rate (L/ha or kg/ha)} \times 0.4 = \text{pesticide rate (L/acre or kg/acre)}$$

3. How much pesticide should you buy?

When you have done the calculations above, and have the pesticide rate, you will be ready to calculate the amount of pesticide you need.

- Multiply the area you want to cover (#1 above) by the pesticide rate (#2 above).

Litres or kilograms to buy =

- area to cover (ha) x pesticide rate (L/ha or kg/ha)
- or
- area to cover (acres) x pesticide rate (L/acre or kg/acre)

Calculations for a Full Tank

4. How much area does one full tank cover?

Divide the tank size by the sprayer output. You find the sprayer output by calibrating your sprayer.

$$\frac{\text{tank size (L)}}{\text{sprayer output (L/ha)}} = \text{number of ha 1 tank will cover}$$

or

$$\frac{\text{tank size (gal)}}{\text{sprayer output (gal/acre)}} = \text{number of acres 1 tank will cover}$$

or

$$\frac{\text{tank size (L)}}{\text{sprayer output (L/acre)}} = \text{number of acres 1 tank will cover}$$

(Be sure you know whether your sprayer uses U.S. gallons or Imperial gallons).

5. How much pesticide should you add to a full tank?

- Multiply the area covered by one tank (step 4) by the pesticide rate you are using (step 2).

Litres or kilograms to add per tank =

$$\text{area covered by one tank (ha)} \quad \times \quad \text{pesticide rate (L/ha or kg/ha)}$$

or

$$\text{area covered by one tank (acres)} \quad \times \quad \text{pesticide rate (L/acre or kg/acre)}$$

**Calculations for
a Part Tank**

6. How much area is left to be sprayed?

- Subtract the area you have already sprayed from the total area.

Area left to spray =

$$\text{total area} \quad - \quad \text{area already sprayed}$$

or

$$\text{total area} \quad - \quad (\text{number of tanks} \times \text{area covered by one tank})$$

7. How much pesticide should you add to a part tank?

Pesticide to add to a part tank =

$$\text{area to be sprayed (ha)} \quad \times \quad \text{pesticide rate (L/ha or kg/ha)}$$

or

$$\text{area to be sprayed (acre)} \quad \times \quad \text{pesticide rate (L/acre or kg/acre)}$$

8. How much spray mix is needed for the part tank?

- Multiply the area that is left to spray by the sprayer output.

Spray mix needed for a part tank =

$$\text{area left to spray (ha)} \quad \times \quad \text{sprayer output (L/ha)}$$

or

$$\text{area left to spray (acre)} \quad \times \quad \text{sprayer output (gal/acre)}$$

Sample Problem 1: (Metric measures)

The label recommends applying **3 L/ha** of pesticide to your crop. You have calibrated your sprayer and the output is **50 L/ha**. Your spray tank holds **400 L** of solution. Your field is **500 m** long and **200 m** wide.

1. How large is the treatment area?

$$\text{ha} = \frac{\text{length (m)} \times \text{width (m)}}{10,000 \text{ m}^2/\text{ha}} = \frac{500 \text{ m} \times 200 \text{ m}}{10,000 \text{ m}^2/\text{ha}} = 10 \text{ ha}$$

The treatment area is 10 ha.

2. What is the pesticide rate?

$$\text{pesticide rate} = \text{label rate} = 3 \text{ L/ha}$$

The pesticide rate is 3 L/ha.

3. How much pesticide should you buy?

Litres to buy =

$$\begin{array}{rcl} \text{area to be sprayed} & \times & \text{pesticide rate} \\ 10 \text{ ha} & \times & 3 \text{ L/ha} = 30 \text{ L} \end{array}$$

You should buy 30 L of pesticide.

4. How much area does one full tank cover?

$$\begin{aligned} \text{Area covered by one tank} &= \frac{\text{tank size (L)}}{\text{sprayer output (L/ha)}} \\ &= \frac{400 \text{ L}}{50 \text{ L/ha}} \\ &= 8 \text{ ha} \end{aligned}$$

One full tank covers 8 ha.

5. How much pesticide should you add to a full tank?

- Multiply the area covered by a full tank (step 4) by the pesticide rate (step 2)

Pesticide to add per tank =

$$\begin{array}{rcll} \text{area covered by one tank (ha)} & \times & \text{pesticide rate (L/ha)} & \\ 8 \text{ ha} & \times & 3 \text{ L/ha} & = 24 \text{ L} \end{array}$$

You should add 24 L of pesticide to a full tank.

6. How much area is left to be sprayed?

Area left to spray =

$$\text{total area} \quad - \quad \text{area already sprayed}$$

$$10 \text{ ha} \quad - \quad 8 \text{ ha} \quad = \quad 2 \text{ ha}$$

There are 2 hectares left to be sprayed.

7. How much pesticide should you add to a part tank?

- Multiply the area left to spray (step 6) by the pesticide rate (step 2)

Pesticide to add to a part tank =

$$\begin{array}{rcll} \text{area to be sprayed (ha)} & \times & \text{pesticide rate (L/ha)} & \\ 2 \text{ ha} & \times & 3 \text{ L/ha} & = 6 \text{ L} \end{array}$$

You should add 6 L of pesticide to the part tank.

8. How much spray mix is needed for the part tank?

Spray mix needed for the part tank =

area left to spray (ha) x the sprayer output (L/ha)

$$2 \text{ ha} \times 50 \text{ L/ha} = 100 \text{ L}$$

You should add 100 L of spray mix to the part tank.

Sample Problem 2: (Imperial measure)

The label recommends applying **2.5 L/ha** of a pesticide to your crop. You have calibrated your sprayer and found that the output is **20 gal/acre**. Your sprayer holds **200 gallons**. Your field is **950 feet** long and **825 feet** wide.

1. How large is the treatment area?

$$\begin{aligned}\text{Acres} &= \frac{\text{length (feet)} \times \text{width (feet)}}{43,560 \text{ ft}^2/\text{acre}} \\ &= \frac{950 \times 825}{43,560} = 17.94 \text{ or } 18 \text{ acres}\end{aligned}$$

The treatment area is 18 acres.

2. What is the pesticide rate?

$$\begin{aligned}\text{pesticide rate (L/ha)} &= \text{converted label rate} \\ &= \text{label rate (L/ha)} \times 0.4 \\ &= 2.5 \text{ L/ha} \times 0.4 \\ &= 1 \text{ L/acre}\end{aligned}$$

The pesticide rate is 1 L/acre.

3. How much pesticide should you buy?

Litres to buy =

$$\begin{aligned}\text{Area to be sprayed} &\times \text{the pesticide rate} \\ 18 \text{ acres} &\times 1 \text{ L/acre} = 18 \text{ L}\end{aligned}$$

You should buy 18 L of pesticide.

4. How much area does one full tank cover?

$$\begin{aligned}\text{Area covered by one tank} &= \frac{\text{tank size (gal)}}{\text{sprayer output (gal/acre)}} \\ &= \frac{200 \text{ gal}}{20 \text{ gal/acre}} \\ &= 10 \text{ acres}\end{aligned}$$

One full tank covers 10 acres.

5. How much pesticide should you add to a full tank?

- Multiply the area covered by one tank (step 4) by the pesticide rate you are using (step 2)

Pesticide to add per tank =

$$\begin{aligned}\text{area covered by one tank (acres)} &\times \text{pesticide rate (L/acre)} \\ 10 \text{ acres} &\times 1 \text{ L/acre} = 10 \text{ L}\end{aligned}$$

You should add 10 L of pesticide to a full tank.

6. How much area is left to be sprayed?

Area left to spray =

$$\begin{aligned}\text{Total area} &\quad - \quad \text{area already sprayed} \\ 18 \text{ acres} &\quad - \quad 10 \text{ acres} = 8 \text{ acres}\end{aligned}$$

There are 8 acres left to be sprayed.

7. How much pesticide should you add to a part tank?

- Multiply the area left to spray (step 6) by the pesticide rate (step 2)

Pesticide to add to a part tank =

area to be sprayed (acres) x pesticide rate (L/acre)

$$8 \text{ acres} \quad \times \quad 1 \text{ L/acre} \quad = \quad 8 \text{ L}$$

You should add 8 L of pesticide to a part tank.

8. How much spray mix is needed for the part tank?

Spray mix needed for a part tank =

area left to spray (acres) x sprayer output (gal/acre)

$$8 \text{ acres} \quad \times \quad 20 \text{ gal/acre} \quad = \quad 160 \text{ gallons}$$

You should add 160 gallons of spray mix to the part tank.

Remember:

You may not have to calculate all of this information for every question, or for your own fields. Learn how to do the calculations that you need most.

Calculation for Granular Pesticides

Granular pesticides may be applied as a broadcast treatment (over the whole field) or as a band treatment.

The pesticide rate for granular pesticides is usually given as the amount of product to apply to a specific area.

Broadcast Treatment

For example: The label says to use **60 kg** of granular product per hectare. The field that will be treated is **2.6 ha**. The spreader is adjusted and calibrated so that its output is **60 kg/ha**. The hopper holds **30 kg**. The whole field will be treated (broadcast treatment).

1. Determine how large an area one hopperful will treat.

If you plan to treat a large area, you should first find out the area that can be treated by one hopperful.

- Calculate the area that one hopperful should cover, by dividing the hopper capacity by the calibrated output. (See below for how to do this).
- Apply one hopperful, then measure the area that was covered.
- Compare the actual area covered with your calculations to be sure that it is the same as the pesticide rate recommended on the label.

If the actual area covered is smaller, then you are applying too much pesticide. You are wasting pesticide and may damage your crops.

If the actual area covered is larger, then you are using too little pesticide, and the treatment may not be effective.

How to Calculate the Area One Hopperful Should Cover:

The output may be expressed in several ways. We will use kg/ha first, then do the same calculations if the output is measured in g/100 m².

a) If the calibrated output is 60 kg/ha

- Divide the hopper capacity by the calibrated output.

$$\frac{30 \text{ kg}}{60 \text{ kg/ha}} = 0.5 \text{ ha}$$

One hopperful should cover 0.5 hectare. This area can also be expressed as m². Converting to m² may make it easier to measure a test section.

To convert to m²:

- Multiply by 10,000 (the number of m² in a hectare).

$$0.5 \text{ ha} \quad \times \quad 10,000 \quad = \quad 5,000 \text{ m}^2$$

One hopperful should cover 5,000 m².

The test area can be any combination of length and width that multiplies to 5,000 m². (For example, 250 m x 20 m, or 200 m x 25 m).

b) If the calibrated output is 600 g/100 m²

- You must first convert this output to grams per 1 m². Do this by dividing 600 g by 100 m².

$$\text{Output} = \frac{600 \text{ g}}{100 \text{ m}^2} = 6 \text{ g/m}^2$$

Then, divide the hopper capacity (30 kg = 30,000 g) by the calibrated output.

$$\frac{30,000 \text{ g}}{6 \text{ g/m}^2} = 5,000 \text{ m}^2$$

One hopper should cover 5,000 m².

The test area can be any combination of length and width that multiplies to 5,000 m².

2. Determine how much pesticide is required for the total treatment.

- Multiply the size of the field by the calibrated output.

$$2.6 \text{ ha} \times 60 \text{ kg/ha} = 156 \text{ kg}$$

You will need 156 kg of pesticide for the total treatment

3. Determine how many hoppers are required.

- Divide the total pesticide required by the capacity of the hopper.

$$\frac{156 \text{ kg}}{30 \text{ kg}} = 5.2 \text{ hoppers}$$

You will use 5 full hoppers and a part one (0.2 or one-fifth).

Band Treatment

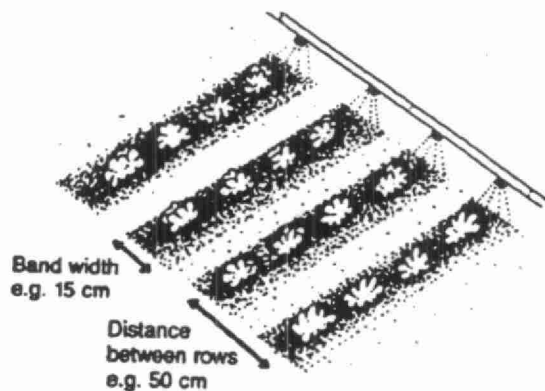
For a **band treatment**, where only crop rows or spaces between crop rows are treated, an additional step may be needed. If you know the calibrated output for only the treated bands, then you must calculate the output for the total area of the field.

Example: The calibrated output per band is 60 kg/ha. The crop rows are spaced at 50 cm and the band width is 15 cm.

First - convert pesticide applied per band to pesticide applied per total area. To do this, multiply:

$$\begin{array}{rcl} \text{Output per band} & \times & \frac{\text{the width of the band}}{\text{distance between rows}} \\ 60 \text{ kg/ha} & \times & \frac{15 \text{ cm}}{50 \text{ cm}} = 18 \text{ kg/ha} \end{array}$$

**Relationship
between band
widths and
distance between
crop rows**



The output averaged over the whole field would be 18 kg/ha.

Use this rate in the rest of the calculations.

Then:

Follow Steps 1 to 3 above to calculate how much pesticide to use.

Measuring by the Length of a Row

For some band treatments, the pesticide rate is given as the amount of pesticide to apply per length of crop row (e.g. apply 40 g/100 m row). Calculate how much pesticide you require per length of row as in Steps 1 to 3 above.

Example: Calculate how much pesticide is required to treat **20,000 linear metres** of crop row if the pesticide rate is **40 g/100 m** row.

Multiply:

$$\begin{array}{rclcl} \text{Pesticide rate} & & \times & \text{total length of crop} & \\ & & & & \\ \frac{40 \text{ g}}{100 \text{ m}} & \times & 20,000 \text{ m} & = & 8,000 \text{ grams} \end{array}$$

Since there are 1,000 grams in one kilogram, you can divide by 1,000 to give the amount in kilograms.

$$\frac{8,000}{1,000} = 8 \text{ kilograms}$$

Review Questions

1. It is important to follow the application rate shown on the label. Application rates that are higher than label recommendations may lead to:
 - a) residue problems in soil
 - b) damage to the crop
 - c) increased production costs
 - d) pesticide residues in the harvested crop
 - e) all of the above

2. A grower would like to spray a field of sweet corn with SEVIN XLR. The recommended rate is 2 L/ha. The output of the sprayer is 250 L/ha. Its capacity is 1,000 litres.
 - a) The field will be sprayed twice during the season. How much SEVIN XLR does the grower need to buy to spray his 10 hectare crop twice?

 - b) How many hectares would be covered by one full tank?

 - c) How much SEVIN XLR should be added to each full spray tank?

3. A farmer has 45 acres of potatoes. He needs to spray BRAVO to control disease at the recommended rate of 2 L/ha. His sprayer output is 50 gallons/acre, and it has a capacity of 500 gallons.

Note: $L/ha \times 0.4 = L/acre$

a) How many litres of BRAVO does he need to buy to cover the 45 acres?

b) How many acres can he spray with a full tank?

c) How many litres of BRAVO should be added to one full tank?

Keeping Pesticide Records

Advise your customers to keep accurate records of their pesticide applications. If they are applying or supervising the application of pesticides, they should keep a record of the application for future reference. Records will prove useful later when trying to decide on re-entry dates, harvest dates, time of next application, equipment settings, application rates, or trouble areas. Records of pesticide use will help to protect the applicator and the vendor by providing documentation if a question or problem arises from an application.

Pesticide application records will help to:

- evaluate results
- improve pest control practices and efficiency
- avoid pesticide misuse
- determine pesticide needs
- reduce pesticide inventory
- establish proper use in case of a residue or crop damage question
- solve application problems
- document the use of pesticides in case of law suits
- plan pesticide needs for the next season (e.g. - rotation of pesticides)

The following could be included in the application records:

- **Date & Time of Application** - This information is useful when deciding on the time of re-entry, reapplication, and harvest. The preharvest interval is the time that must pass between application of pesticides and harvest of the crop. It is listed on the label. By recording the application date as well as the preharvest interval, the applicator will know his **earliest harvest date**. This information could actually determine which pesticide he buys.
- **Location of Application** - Results/Effectiveness of application can be determined. If the applicator records the area that has been sprayed, he will not respray/overspray the area.
- **Pest & Host** - The applicator should record the name and the stage of growth of the pest and host. Both are important when deciding on the best pesticide to use, the application time and rate.
- **Pesticide (trade name & PCP Act #)** - In the event of a spill, property damage, poisoning or legal action, it is important to be able to access the name of the pesticide, the formulation, and the PCP Act#.
- **Rate of Application** - This information is useful when comparing the results to other pesticides or comparing various rates of the same pesticide. The water volume used per hectare should also be recorded.
- **Applicators Name** - It is always good practice to record who actually applied the chemical.
- **Equipment** i.e. nozzles, pressure, spacing, speed - By recording what equipment and settings are used to apply the pesticide, the applicator will be able to evaluate the effectiveness of the pesticide at different sprayer pressures, speeds, and nozzle spacings. Decisions can be made as to whether to change any of these settings next time. An applicator should make a note of nozzle type and when he changed the nozzles. This will help him estimate the expected wear of the nozzles.
- **Weather Conditions** (eg. rain, wind, temperature) - Weather conditions will affect the chemical treatment as well as amount applied. This information is useful if there is ever a concern regarding effectiveness of the pesticide, property damage, drift, runoff, or other environmental concerns.

- **Surrounding Plants and Animals** - The applicator should make a note of the animals and plants in the surrounding areas. Record whether any damage occurred to plants or animals in areas that were not treated. (The applicator should be able to prevent the damage next time). He should try to determine the cause of the damage so that it can be prevented next time.
- **Results of Application** - A comment on the results of the pesticide application will be useful in future decision making. He should inspect the treated area periodically.

Record Keeping

A good record keeping system is one which:

- provides the information that will be needed later
- is easy to understand
- is easily accessible

There are many charts and record keeping systems that could be used to keep track of as application. A sample chart is shown on the following page.

DON'T TRUST YOUR MEMORY!

A notebook can be kept with the applicator so he can write down the information as it happens. Later, all information can be transferred to a permanent record kept in a home or office. Other employees should be told where this information is kept in case of an emergency.

Plant/Animal Sprayed _____

Location of Application _____

Date of Application _____

Applicator's Name _____

Nozzle Size _____ Pressure _____

Spacing _____ Speed _____

Pest & Growth Stage	Pesticide Used:	Rate of Application
	Product Name:	Sprayer Output:
	PCP Act #:	Pesticide Rate:
Date of Re-entry	Weather	Other Observations
		e.g. - surrounding plants and animals
Reapplication Date		
Earliest Harvest Date		
Results/Comments		

Review Questions

1. List 3 reasons to keep good records of a pesticide application.

1. _____
2. _____
3. _____

Health and Safety on the Job

The purpose of the Occupational Health and Safety Act (Ontario Ministry of Labour) is to prevent accidents and injuries. Employers, employees and supervisors must co-operate to reduce injuries and illnesses on the job.

Under the law, your employer has the most responsibility for health and safety in the work place. However, employees and supervisors also have duties and responsibilities.

What You and your Employer Must Do

Protective Clothing and Equipment

Your employer must, in most cases, make sure that you have the proper protective clothing and equipment. Your employer must make sure that all employees know how to use safety equipment properly.

Your supervisor must make sure that you use protective clothing and safety equipment properly.

As an employee, you must wear any protective clothing or equipment that is required. If any protective clothing or equipment is missing or not working properly, you must report it to your employer.

Information and Training

Your employer must give you information about any hazardous substance you work with. Your employer must also train you to work safely with these substances.

Presently, pesticides are exempt from the WHMIS rules on labelling and Material Safety Data Sheets because they are already covered under the Pest Control Products Act. However, Material Safety Data Sheets are available for most pesticides. They provide the most complete information about pesticides and the hazards of using them. Ask your employer about the Material Safety Data Sheets for the pesticides you handle.

It is your right to ask for information about the substances you work with. Your supervisor must tell you about any possible danger to your health and safety. It is also your right to be shown how to handle these substances safely to reduce the danger of exposure.

Before you work with any pesticide, find out as much information as you can. You can get information from the supplier if your employer does not have it in the workplace.

Health and Safety Committees

Health and Safety Committees are required by law in almost every workplace with 20 or more employees. Every work place that has more than five employees must have a health and safety representative if it does not have a health and safety committee.

As of April 5, 1993, at least two people who serve on the health and safety committee must be certified by the Ministry of Labour. One person must be a manager and the other must be a worker. To be certified, an employee must take a certification course.

The Ontario Occupational Health and Safety Act gives complete information about what is required. You can also get material from the Ontario Ministry of Labour that explains the law. For more information, call the Workplace Health and Safety Agency. The number is 1-800-268-2378.

Review Questions

1. List some sources of information you can get that will tell you about the pesticides you are using at your workplace.

Pesticide Spills

Preventing Spills

Pesticide accidents do happen. When they occur be ready to act effectively and quickly. All employees should know what to do when a pesticide spill or fire occurs. They should all be aware of the hazards in a pesticide accident. Train employees to use protective clothing and equipment properly. If everyone is well prepared, you can reduce health hazards and environmental damage to a minimum.

You can reduce the risk of leaking containers or pesticide spills through good storage practices, proper handling (including forklift operation), and regular inventory inspection.

Consider building a system to contain spills in your warehouse areas. A containment system will minimize environmental damage if a major spill occurs. It will also make the clean-up easier and less costly.

The design of your containment system will depend on the types and quantities of pesticide you store. It could be as simple as instructions for diking and damming runoff. Or, you could build an integrated drainage system leading into a concrete pond or tank. Provincial authorities can give you advice on what would be best for your business.

Environmental Protection Act

The purpose of the Environmental Protection Act is to protect and conserve the natural environment. This Act is administered by the Ministry of Environment and Energy. It would apply to pesticides if they are discharged into the natural environment.

Part X of the **Environmental Protection Act** is commonly known as the "Spills Bill". It regulates the spill of any kind of pollutant.

Part X of the Environmental Protection Act, requires that:

1. **Spills must be reported** to the Ministry of Environment and Energy and the municipality if there is any possibility that the spill may cause adverse (harmful) effects.

The Ministry of Environment and Energy established the Spills Action Centre to receive calls 24 hours a day (1-800-268-6060). Your local municipality may have additional reporting numbers.

2. **Spills must be cleaned up.** The Spills Action Centre will give advice on how to deal with the spill.
3. **Anyone affected by the spill must be compensated.**

A spill is defined as a discharge of a pollutant:

- into the natural environment
- from, or out of, a structure, vehicle, or other container, and
- **that is abnormal in quality or quantity**

A discharge must meet all three criteria to be considered a spill.

A spill must be reported when it causes, or is likely to cause, any of the following adverse effects:

- any impairment to the quality of the natural environment - air, water, land
- any injury or damage to property, plants or animal life
- harm or material discomfort
- adverse health effects

- impairment to safety
- loss of enjoyment of normal use of property
- interference with the normal conduct of business.

The owner of the material, or the person who had control of it immediately before the spill, must assess the situation and take responsibility for the spill even if they are not at fault. The owner/controller may later seek compensation from those responsible.

If the owner/controller is not at fault for the spill, and is not able to get compensation from those who are liable for the spill, including insurers and those at fault, then he may apply to the **Environmental Compensation Corporation (ECC)**.

The ECC may compensate the owner/controller for amounts paid to spill victims and for costs incurred on behalf of others. If the owner/controller is at fault for the spill, there will be no compensation from the ECC.

As long as the person has reported and cleaned up the spill, his liability for all costs is limited to \$500,000. Check your insurance policy to make sure you are covered for this liability.

People are often the victims of a spill. Under this Act, the person is entitled to compensation from the owner of the spilled material or the person who had control of the material immediately before the spill. If the person does not get compensation he can apply to the ECC.

What to do When a Spill Occurs

If a spill happens, the first job is to evacuate everyone from the immediate spill area.

Protect yourself from injury. Always put on protective clothing and equipment before entering a contaminated area or handling a patient.

If any person has come into contact with the pesticide, stop the exposure quickly. Move the patient from the contaminated area and remove all contaminated clothing. Wash the affected skin with soap and water to prevent further exposure. Other first aid procedures may be necessary. Get medical attention.

Employees who will be involved in spill cleanup must wear proper protective clothing and equipment. Ventilate the area before entering the spill site. The first job for the cleanup crew should be to contain the spilled chemicals on the site. Prevent the spill from entering storm drains, wells, water systems, and waterways.

Here are some procedures to follow:

- Wear protective clothing and equipment.
- Evacuate the area.
- Prevent further exposure.
- Remove contaminated clothing/items.
- Wash with soap and water.
- Administer first aid.
- Get medical attention.
- Ventilate the area.
- Contain the spill.
- Contact the Spills Action Centre.

Remember,

if the spill causes, or is likely to cause any of the adverse effects noted on page 270, you must report the spill immediately by calling:

**Spills Action Centre
1-800-268-6060**

Decontamination Kit

Decontamination kits should be assembled in advance. They should contain all the emergency equipment needed for all pesticide products kept in storage. These kits should be labelled and inspected regularly.

Make sure that decontamination kits are easy to get at in an emergency.

A decontamination kit should include:

- 2 x 4 litre containers sodium hypochlorite (laundry bleach)
- 1 x 12 litre package of heavy duty detergent
- 4 x 25 kilogram bags of absorbent material (Attaclay granules)
- 4 x 25 kilogram bags of hydrated lime
- 2 square-mouth shovels or spades
- 2 yard brooms
- 1 hand pump with hose
- 2 x 205 litre open-head drums with lids
- 2 sealable drums for use with 205 litre drums
- 2 x 20 litre open-head pails with lids
- 2 heavy plastic bags
- 2 cartridge type respirators
- 2 pairs safety goggles
- 4 pairs industrial chemical resistant gloves
- 2 pairs chemical resistant boots
- 2 pairs coveralls

Cleanup Procedures

Follow the steps below if a pesticide container is damaged:

Dry Material

For spills of dry pesticide:

- Wear appropriate protective clothing and equipment.
- Ventilate the spill area.
- Place damaged containers of dry material in heavy duty drums or other suitable containers.
- Sweep or shovel the material into plastic bags and place them in sealed drums or other suitable containers.

Sweep slowly and carefully to keep the pesticide dust on the ground. Seal the bags and drums and label them according to contents. Place the sealed drums in a previously designated area of the warehouse for future disposal. Decontaminate the spill area before using it again. Refer to the product's Material Safety Data Sheet for decontamination steps or contact the manufacturer.

Liquid Material

For spills of liquid pesticides:

- Wear appropriate protective equipment
- Ventilate the spill area.
- Stop the damaged container from leaking. Turn it upside down or pour the contents into another container and relabel, (Reg. 914, s.26). Place the damaged container inside a sealable drum.
- Cover the spill using an absorbent material. (soil, kitty litter, commercial products specific for spills, etc. - do not use sawdust)
- Clean up the absorbent material by sweeping or shovelling it into a sealable drum or other suitable container.

Decontaminate the spill area before using it again. Refer to the product's Material Safety Data Sheet for decontamination steps or contact the manufacturer.

Contaminated Containers

Isolate any containers which have been contaminated by the spill. It may be possible to clean pesticide from the outside of these contaminated containers by using decontamination procedures outlined in the MSDS.

Decontamination Procedure

Wear the appropriate protective clothing and equipment to decontaminate the area. Decontamination can begin after most of the dry or liquid chemicals have been transferred into the drums. Refer to the Material Safety Data Sheet to find out how to decontaminate the area.

Keep all contaminated clothing and tools in plastic bags until they can be decontaminated. Remember to wear chemically resistant gloves whenever you handle contaminated items.

Disposal

Before disposing of the cleanup material consult with the Ontario Ministry of Environment and Energy. They will give you advice on proper disposal. The Ontario Ministry of Environment and Energy will also recommend a disposal site.

The drums containing the clean-up material should be covered and labelled with "spilled pesticide - DANGER" and the name of the pesticide. Take the drums to the disposal site designated by the provincial environment officials. DO NOT take these drums to a garbage dump unless environment officials have authorized you to do so. Remember to follow all provincial regulations for transporting pesticides when taking the containers to the disposal site.

Personal Hygiene

After the spill has been cleaned up, all workers must take a shower and change into clean clothing. If clothing becomes contaminated, shower and change immediately even if the clean-up is not finished. Wash all clothing, boots, gloves, etc. with soap and water as soon as possible.

If any person involved in the accident or clean-up begins to feel sick (nausea, headache, etc.), take him or her to the nearest hospital immediately. Take along information on the pesticide. You can find this information on the label of an undamaged container or by phoning the manufacturer for information. The PCP Act registration number identifies the product immediately for the manufacturer and the Poison Information Centre.

Review Questions

1. For a pesticide spill, what is the first step in proper cleanup?

Pesticide Fires

A fire in a pesticide storage area can be extremely dangerous. There is the hazard of the fire itself, plus the additional danger of pesticide poisoning and environmental contamination. Reducing the risk to life and property depends on a good emergency plan. Develop this plan before a fire occurs.

Pre-Fire Plan

Prepare for the possibility of a fire. You will have a greater chance of reducing health hazards and environmental contamination.

1. Inform the local fire department that you store pesticides so that the fire fighters can be prepared for the dangers involved.

Remember: The law says that: (Reg. 914, s.124)

- All wholesalers that store any pesticides must notify the fire department that pesticides are stored in their warehouse.
- Retail Class 1 & 2 vendors that store Schedules 1, 2 & 5 pesticides must notify the fire department that pesticides are stored in their warehouse.

2. Invite the fire department to visit your warehouse so that they know where the pesticides are stored and in what quantities.
3. Store all of your pesticides in one area.
4. Keep an up-to-date inventory of the pesticides.

5. Take the time to carefully map a floor plan of the pesticide storage facility and the immediate surrounding area. The sketch of the storage area should:
 - locate all emergency and protective equipment plus indicate the position of all windows and doors
 - indicate all water sources and the volume of water available for fire fighting
 - map the drainage system of the site to help determine how to control runoff water
 - note nearby buildings and their functions
 - include the fence line showing all access routes
6. Make a plan for dikes and drainage so that runoff water is prevented from entering waterways.
7. Teach your employees what to do in an emergency. It's a good idea to have a written emergency fire plan and to have regular fire drills. Workers should also be trained in the proper use of safety equipment. This will ensure that all employees can respond properly in an emergency situation. Remember to inform all employees if any changes are made to the plan.
8. Prepare procedures for evacuating and notifying the fire department. Do not take unnecessary risks in fire fighting. It is wiser to wait for the fire department than to be poisoned or injured.

Fire Plan

Make a detailed, step-by-step plan of what to do if a fire occurs. Identify in advance one knowledgeable person to co-ordinate activities with emergency personnel and to respond to news media questions.

1. **Evacuate and isolate the area immediately.** Anyone in the vicinity of the fire may be exposed to toxic fumes, poisonous runoff and concentrated pesticides from leaking or exploding storage containers. Account for all personnel.
2. **Call the local fire department** immediately when smoke or fire is first detected. Remind fire fighters of the additional danger of burning pesticides and of the importance of wearing air-supplied respirators.
3. **Call the local Ontario Ministry of Environment and Energy office or the Spills Action Centre.** They can advise you of special precautions or send an expert to the site. (Reg. 914, s.29).
4. **Call the police for traffic control** and ensure the safety of people living in the area.
5. **Call the local medical authorities** and the nearest Poison Information Centre and advise them of the chemicals involved.
6. **Determine the location and extent** of the fire if possible.

What to Tell Fire Fighters

- Tell the fire department what pesticides are in the affected area. Provide Material Safety Data Sheets if available.
- Anyone directly involved with the fire should use self-contained breathing apparatus and cover the body completely.
- Foam or fog nozzles are recommended when fighting a pesticide fire. Advise fire fighters to use as little water as possible to avoid contaminating the surrounding area. Control all runoff water.

Advise health and other emergency authorities that:

- All personnel should be kept out of the smoke or mist created by the fire.
- Everyone should wear protective equipment to protect against spills, splashes and toxic fumes.

Post-fire Actions

After the fire is under control:

- Rope the area off and post a 24-hour guard to prevent anyone from entering.
- All fire fighting equipment, including hoses, should be decontaminated on site to prevent off-site health or environmental problems.
- Advise anyone involved in fighting the fire to report any sickness, nausea or other health effects that develop within 48 hours after the fire.
- Make special arrangements to dispose of the debris according to provincial regulations.

Fire Hazards

- Pesticides may be highly flammable or explosive.
- Fires may give off fumes or smoke highly toxic to fire fighters and residents. It may be necessary to evacuate the surrounding area depending upon the extent of the fire. The toxicity and hazard of many pesticides burning together is unknown.
- Fumes and smoke may adversely affect vegetation in the surrounding area.
- Runoff water may be highly toxic. Make sure runoff water is prevented from entering any street sewer, culvert, ditch, or stream leading off the property. Dikes or sandbags should be used when necessary to divert contaminated water from streams or critical areas. Know where to set up dikes and what material is required.

Fire Prevention

Everyone hopes that a fire will never happen. Here are some things you can do to help prevent a fire.

- Do not use open flames for welding, burning, cutting, etc. in the pesticide storage. If you must make repairs, remove the pesticides from the area first. Make sure that a fire extinguisher is close by.
- Use stretch wrapping rather than shrink wrapping because stretch wrapping does not require any heat.
- Make sure pesticide storage construction, electrical installations and equipment are up to date and follow the required codes (e.g. - National Fire Code, Building Codes).
- Secure doors and windows to protect your storage from intruders and vandals. Keep unauthorized people from entering to avoid the risk of fire and damage to your property.

Fire Safety Equipment

Make sure that your warehouse is equipped with the right equipment to prevent a fire, or deal with an emergency. You will need smoke alarms, fire extinguishers and personal protective equipment. Large warehouses may also need a sprinkler system.

- Portable fire extinguishers should be located throughout the warehouse. Get advice from the local fire department about the equipment to buy and where to put it.
- Find out from your local fire department if a sprinkler system is required.
- Install a smoke alarm system. The local fire department may be able to recommend a fire detection system that can be wired directly to the fire department. Once a system is installed, remember to check it regularly. If you detect the fire quickly, you can limit damage.
- The Ministry of Labour has guidelines about emergency control and personal protective equipment such as first aid kits, emergency showers, and eye wash stations. Check with the Ministry of Labour for more information.

-

Emergency Planning

A pesticide spill or a warehouse fire may never happen. But, if it does, will you be ready? You can avoid a major disaster if you are well prepared to deal with an emergency.

An Emergency Response Plan is important. It will:

- prevent an emergency from becoming a major disaster
- protect the community
- protect your business
- protect your employees
- reduce your liability for damages
- keep environmental damage to a minimum
- build confidence with your neighbours

You need to plan for all kinds of emergencies. When designing the Emergency Response Plan, include procedures for:

- fires
- explosion
- gas and odour release
- spills
- serious injury
- natural disasters (lightening, tornado, etc.)
- threats (phone calls, etc.)
- transport accidents (highway and rail)

The procedures you use will depend on the kind of emergency.

Emergency Response Plan

There are eight steps to an Emergency Response Plan:

1. **Assign emergency co-ordinators.** One person must be given overall responsibility. Then assign co-ordinators for specific duties. You may need someone to co-ordinate:

- communication
- site security and transportation
- first aid
- fire fighting
- environmental control
- plant operations

Your emergency response team should have the authority to direct and manage employees. They should be available 24 hours a day. Alternate employees should be ready to take over if any team member is not available. In small businesses, one person may be responsible for all duties.

2. **Make an emergency calling list.** Make a list of the local authorities who need to be called when an emergency happens. List them in the order that they should be called. On the calling list, note the information that you need to give the authorities. This includes:

- your name
- location of accident
- description of emergency
- products and quantities involved
- injuries
- potential dangers

Groups to inform include:

- employees on site
- managers, supervisors off site
- Fire Department, Police
- Ministry of Environment and Energy local office or Spills Action Centre
- neighbours
- lawyer
- insurance agency
- other citizens
- media

Keep a record of the time you called and the name of the person you reached. You may need this information in court.

3. **Make a list of emergency helpers from the community.** Contact neighbouring businesses to see if they could help in an emergency. Get a contact name and number and list the equipment they have available. Be sure to note the time needed for them to respond. For example, you may need materials from the local gravel pit for dikes, or you may need to hire a back hoe. Who will you contact? Will they know what to do?
4. **Map the warehouse and surrounding area.** The map should include:
 - all buildings, tanks, loading docks, containments
 - waterways, sewers, drains
 - outside perimeter fencing
 - access routes
 - main shutoff for electricity, water, gas
 - areas of hazardous materials
 - location of emergency equipment
 - directions (north/south)
 - instructions for building dikes and dams to block runoff
 - evacuation area, routes, shelters that could be used
 - neighbouring residents
5. **Keep accurate inventory records at your business** but away from the warehouse. Include pesticide product names, PCP Act registration numbers, volume stored, and location. Keep product labels and MSDS's for information. If any product requires special emergency treatment, make a note of it.
6. **Have all the emergency equipment you need and keep it in working condition.** Examples include fire extinguishers, protective clothing and equipment, and containment equipment. Check with the fire department to find out exactly what you need.

7. **Outline the emergency procedures in the exact order they need to be done.** When writing the step by step procedures consider the following:

- emergencies you can handle
- emergencies needing outside help
- procedures for each kind of emergency
- evacuation procedure
- every task that must be done
- the person responsible for each task (put a name beside every task)
- training for your employees

Talk to provincial authorities, a lawyer, and your insurance agent to make sure you have included everything you need.

Invite outside helpers to tour your facility and discuss how you can work together in an emergency. Be sure they understand their responsibilities.

Practice your emergency procedures so everyone knows what to do.

8. **File the plan with responsible employees and local authorities.** Update it every year, or any time that you make changes in the facilities or the products you carry. Be sure to keep your employees informed of any changes.

Your emergency response plan may be your most important business document. It can prevent a minor emergency from becoming a major disaster.

Review Questions

1. A truck transporting pesticides turns over on a country road near a stream. The containers are damaged and are leaking on the road. The load contained:

GUTHION
DIAZINON
GRAMOXONE
AMBUSH

List the emergency procedures you should follow:

2. Who should you review your emergency plan with?

Be A Professional

It is important to be able to assure the public that pesticides are being handled responsibly in your business. To develop and maintain good public relations, you should:

- Be informed about the products you sell.
- Have a professional attitude.
- Have a professional image.
- Communicate with your customers and your local community.

Knowledge

Be Informed about the Products You Sell

Your customers rely on you to help them make good decisions about pest management. That means you have to know about - the pest to be controlled, the crops or animals to be treated, the pesticides that could be used, the effects on the environment, safety practices, and federal, provincial and local laws.

Learning is an ongoing activity. Keep up to date by reading information about your products and attending seminars and trade shows. Talk to government employees and company representatives.

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) regularly updates their publications on pest control methods to include new research. You can keep up to date by reading these publications. Learn where to go for answers to your customer's questions. If you don't know the answer, help your customer find the information.

There are also many private industry publications such as sprayer and nozzle guides that provide detailed information. Talk to your suppliers to keep up to date with their products.

Attitude

Have a Professional Attitude

- Identify yourself to your customer.
- Be respectful, honest, polite and courteous.
- Spend time with your customers.
- Try to answer their questions or complaints.
- Work safely.
- Consider nearby property owners
- Comply with all pesticide legislation.
- Only make a recommendation when you know that you are right.

Image

Have a Professional Image

- Make sure your premises are clean and tidy.
- Follow all safety regulations.
- Make sure your employees wear protective clothing when handling pesticides.
- Be serious about your record-keeping.
- Keep emergency telephone numbers on hand.
- Set a good example for your customers, and it will increase their confidence in you.

Communicate

Communicate with Your Customers and the Community

Communication means listening as well as speaking. Try to understand the things that concern your customers and your community. Try to keep the community informed about your business practices, especially when it affects their safety. Consider inviting the community for a tour of your facilities to relieve any concerns they may have about safety.

Make sure you talk to the police and local fire fighters to develop a plan for handling an emergency. If everyone knows what to do, you can all be confident about handling an emergency well.

Review Questions

1. List 4 ways to develop and maintain good public relations.

1. _____
2. _____
3. _____
4. _____

Appendices

Glossary of Terms	297
Answers to Review Questions	313
Information Numbers	329
MOEE Pesticides Control Field Offices	331
Safety Supply Companies	333
The Metric System	337
References	341
Notes	345



Glossary of Terms

a.i.	Active ingredient in a pesticide formulation.
abrasion	Damage that results from contact with rough material.
absorbent material	Material which can take up chemicals and hold them. Sometimes used to clean up pesticide spills. Example: clay powder, kitty litter.
absorption	Movement into a plant, animal, or soil, of a substance placed on its surface.
absorption rate	The amount of material absorbed in a specific period of time.
acetylcholine	A chemical formed at the ends of nerves to conduct nerve impulses over the microscopic gap between nerves or between a nerve and a muscle or gland.
activated charcoal	A finely ground form of charcoal used to absorb gases and vapours in cartridge respirators.
active ingredient (a.i.)	The part of a pesticide formulation that controls the pest.
acute exposure	A single exposure to a substance.
acute poisoning	Poisoning which occurs after a short period of exposure to a pesticide.
acute toxicity	The toxic response resulting from a single exposure to a pesticide. Determined through oral, dermal or inhalation studies.
adjuvant	A substance added to a pesticide solution to improve effectiveness of the active ingredient. Examples: emulsifiers, wetting agents, surfactants.
adsorption	The process of a substance being attracted to, or "sticking to", soil particles.
aerosol (pressurized can)	Pesticide driven by an inactive gas under pressure, producing very fine solid or liquid particles suspended in air.
agitation	The movement of a liquid pesticide to keep the contents mixed.
agriculturist	A person who makes a living by crop or animal husbandry. A farmer.

air blast sprayer	An applicator which propels spray droplets in an airstream, used for spraying orchards.
air shear nozzle	Used with a high velocity air stream to break up a stream of liquid into fine droplets.
air sparging	Agitation (bubbles) caused when air is forced into the bottom of a tank and up through a solution.
alternate host	A plant (other than your crop) that allows an insect or disease to grow and reproduce. It can act as a source for infection of crops.
annual	A plant which completes its life cycle in one year.
antidote	A remedy given by a doctor to counteract the effects of a poison.
apiarist	A beekeeper.
application rate	The amount of pesticide applied to a specific area (e.g. - 5 kg per hectare). The application rate is found on the label.
artificial respiration (A.R.)	First aid method to establish and maintain breathing.
atomizing nozzles	Nozzles which have a very small opening. When used with a liquid under high pressure, they create very fine droplets like a mist or fog.
atropine	A drug administered by a doctor to those poisoned by organo-phosphorous and carbamate insecticides.
attractants	Substances which may attract female insects for egg laying or attract male insects to artificial female traps.
bactericides	A pesticide used to control or kill bacteria.
ball check strainer	A screen strainer located at a nozzle which contains a small spring-loaded ball bearing. The ball bearing acts as a shut-off valve to prevent dripping from the nozzle when the spray pressure is turned off.
base level	The "normal" level of cholinesterase present in the blood when a person is not exposed to organophosphorus or carbamate insecticides. It is compared to the level during the spraying season to determine whether there are signs of insecticide poisoning.
biennial	A plant which completes its life cycle in two years.

bio-accumulation	The ability of some pesticides to build up in the body tissues (especially fat cells) of animals. Small amounts of pesticide gradually build up over time and can cause death or long-term damage.
biological control	The use of living things such as birds or insects to control pests.
bio-magnification	When pesticides accumulate in animals that are part of a food chain, the last animal of the chain receives very high levels of pesticides which can cause death or long-term damage.
boom sprayer	Equipment that delivers spray droplets through nozzles on a boom (pipe or tube) directly onto the soil or crop. Most common type of sprayer.
boomless sprayer	A sprayer that uses special nozzles or a pivoting single nozzle to cover a swath. It does not require a boom.
canister gas mask	A metal or plastic container filled with absorbent materials. It is designed to filter gases and vapours from the air. The canister may also contain a physical filter to remove solid or liquid particles.
CANUTEC	Canadian Transport Emergency Centre established to give information on chemicals. Operated by Transport Canada.
carbamate insecticide	Organic pesticides that can have similar toxic effects as organophosphorus insecticides.
carrier	Material added to a pesticide product to dilute it to produce even distribution. The carrier is usually water but it may also be talc (dust), oil or other solvents.
cartridge	The small, detachable part of the air-purifying respirator which is designed to absorb gases and vapours from air.
caustic	A corrosive chemical that can burn the skin. Caustics have pH values greater than 7.
chemical control	Pest control method which includes the use of chemical pesticides to kill or control the pest populations.
centrifugal pump	A pump which moves liquid from an inlet valve to an outlet valve by rapid rotation of a central shaft enclosed in a hollow body.
chisel cultivator	A cultivator that has a sharp leading edge and flared sides. Used to rip apart sod and soil.

cholinesterase	An enzyme found in humans necessary for the proper functioning of the nervous system. Organophosphorus and carbamate insecticides are cholinesterase inhibitors.
cholinesterase level	The amount of cholinesterase in a person's blood.
chronic exposure	Repeated exposure to a substance over a longer period of time.
chronic poisoning	Poisoning which occurs after repeated exposure to a pesticide over an extended period.
chronic toxicity	The toxic response resulting from repeated exposure to small doses of pesticide over a long period of time.
classification (scheduling)	<p>a) The system used in Ontario to classify federally registered products by their toxicity and environmental and health hazards. It restricts the access of pesticides in Ontario.</p> <p>b) Federal system to group products by use and toxicity as either DOMESTIC, COMMERCIAL, RESTRICTED or MANUFACTURING.</p>
common name (CSA chemical name)	The simplified chemical name of the active ingredient of a pesticide appearing on the label as the guarantee (also called generic name).
compatibility	When two or more pesticides are added to a spray tank, mix satisfactorily and, when combined, work effectively together.
complete metamorphosis	The life cycle of an insect which includes egg, larva (grub or caterpillar), pupa and adult.
compound leaf	A leaf divided into separate leaflets.
compressed-air sprayer	A vacuum drawing a fixed rate of pesticide from a small spray tank to mix with water flowing through a hose.
concentrate	The pesticide formulation sold by the vendor to the user before being diluted with water or oil.
concentration	The amount of a substance contained in a mixture. Usually expressed as a percentage by weight or per unit of volume. Often refers to the active ingredient in a pesticide product.

confined space	An enclosure or partial enclosure having limited means of entry or exit, with poor natural ventilation. Confined spaces may contain hazardous contaminants or be oxygen-deficient, e.g. mushroom houses, greenhouses. All confined spaces are considered immediately dangerous to life or health unless proven otherwise.
contact pesticide	A pesticide which must come in contact with the pest to be effective. They can be applied to the pest or on surfaces the pests touch.
contaminate (contamination)	To alter a material by the introduction of a chemical, so that it is unfit for a specified use.
corrosion	The physical breakdown of a material caused by a chemical reaction. For example - the rusting of metal caused by salt, water and air.
corrosive	A substance that contains an acid or caustic which may chemically burn the skin, mouth, stomach, etc. Corrosives may also attack metal parts (e.g. metal pesticide application equipment and storage containers).
cotyledon	First leaves to appear on the stem of a broadleaf plant.
cultipacker	An implement for cultivating soil. A roller helps to break up clods and form a smooth surface suitable for planting.
cultivar	A cultivated variety of plant, such as named vegetable crops.
cultural control	Pest control method using practices common to good land management.
data	Accumulated information such as that required for registration of a pesticide.
days to harvest	The least number of days between the last pesticide application and the harvest date as indicated on the label.
decontaminate (decontamination)	To remove pesticide residues by (1) washing with water, (2) absorbing, or neutralizing with sand, soil, charcoal or (3) removing.
dermal	Related to the skin.
dermatitis	Inflammation of the skin induced by contact with some agent.
diaphragm pump	A positive displacement pump in which a flexible membrane in a hollow cylinder is moved up and down to draw liquid in, and then force it out.

dilute	To make a pesticide concentration weaker by adding water, oil or inert solids.
drift	Airborne movement of pesticide droplets or particles away from the target area to areas not meant to be treated.
droplets	Individual, small amounts of liquid.
dry flowable	A wettable powder which is formulated into small pellets or granules.
dust or powder	A finely ground dry material of a low concentration (a.i.) plus inerts such as talc. No dilution needed before use.
efficacy	The production of a desired effect.
emulsifiable concentrate	A liquid pesticide formulation consisting of the active ingredient, a solvent, and an emulsifier to facilitate mixing in water.
entomologist	A person who studies insects.
eradicator	A fungicide which is applied to a plant that is infected with disease. It penetrates into the plant tissue and kills the disease organism.
exposure	Contact with a gas, liquid or solid by an applicator or bystander. It can be oral, dermal or respiratory.
face shield	A transparent piece of protective equipment used by an applicator to protect their face from pesticide exposure.
field exposure studies	Tests which are conducted to determine how an applicator is exposed to a pesticide product when using it on the job.
formulation	The form in which a pesticide is sold. It includes the active ingredient, carriers, diluents, or other materials.
fumigant	Pesticides used in the form of volatile liquids or gases.
fumigation	The use of pesticides in gaseous form to destroy pests. Fumigation may be carried out either indoors or outdoors.
fungi (fungus)	Group of small organisms which cause rots, mould and plant diseases.
fungicide	Pesticides used to control fungal plant diseases.
gas	A substance that is in the gaseous state at ordinary temperature and pressure.

gasket	A thin layer of material like cork, rubber, paper, etc., placed between joined metal parts to give a solid seals and prevent leaks.
gear pump	A low pressure pump with two interlocking gears set in an enclosed casing. Liquid enters one valve and is carried between the gear teeth and the casing wall to an outlet valve on the opposite end.
genetic control	Pest control method including the release of sterile insects or selecting disease resistant hybrids.
granular	A mix of dry, large, free-flowing particles usually with a low concentration of a.i.
growth regulators	Substances which act like hormones. They affect the normal development of the organism.
guarantee	The amount of active ingredient in a product as stated on the label. Usually expressed as a percentage by weight or weight per unit volume.
hand pump sprayer	Hand operated plunger which forces pesticide out with the air-flow.
hazard	The danger of exposure when working with pesticides.
herbicide	A pesticide used to control or kill weeds.
hose end sprayer	Draws a fixed rate of pesticide from a small spray tank and mixes it with water flowing through a hose.
hydraulic sprayer	Spray equipment which delivers pesticide as a spray driven by a hydraulic pump.
impregnated fertilizer	Granular fertilizer containing low amount of herbicides.
incomplete metamorphosis	The life cycle of an insect which includes egg, nymph and adult.
incorporate (into soil)	Some pesticides must be covered with soil to prevent breakdown by the sun. The soil must be turned over and the pesticide must be mixed into the top 3 inches of soil.
inert ingredient	Any ingredient in a formulation which has no pesticidal action but may be toxic to the applicator.
ingest (ingestion)	Take through the mouth and swallow.

inhale (inhalation)	Take through nose or mouth when breathing air into the lungs.
insecticide	A pesticide used to control insects.
irritant	A substance which produces symptoms of inflammation on contact with the skin, eyes, nose, throat, lungs and stomach.
jet agitator	A device which injects water at high pressure through a small valve into the tank to agitate a pesticide solution.
LC₅₀ (inhalation toxicity)	The concentration (expressed in parts per million) of a vapour in air which will kill 50% of the test animals when it is inhaled (breathed in) over a set period of time.
LD₅₀ (lethal dose 50%)	A statistical estimate of a chemical dose which will kill 50 percent of test animals, usually within a stated period of observation.
maximum residue limit (MRL)	Established by Health & Welfare Canada and expressed in parts per million. The largest amount of residue allowed, based on toxicity of the pesticide, its application rate and timing and the crop to which it is being applied.
mechanical control	Pest control method using physical practices to prevent the spread of pests or reduce pest populations. Mechanical methods would include netting fruit trees to discourage birds, de-thatching or aerating a lawn.
metabolism	Processes occurring in organisms or cells.
microbial insecticides	Pesticides which contain microbes (tiny organisms) which, when eaten by the pest, kills them.
micro-encapsulated	The pesticide is contained in small capsules which release it slowly.
mist blower	Equipment designed to apply tiny droplets (low volume air sprayers) suspended in air. They use low water volumes.
mite	A tiny animal, similar to an spider, having 8 legs.
miticide	A pesticide used to control or kill mites, also termed acaricide.
negative fit check	A check to be sure that a respirator fits properly.
nematicide	A pesticide used to control or kill nematodes.
nematode	A tiny round worm that causes damage by feeding on roots or other plant parts.

neoprene	Synthetic rubber-like polymer.
NIOSH	The U.S. National Institute for Occupational Safety and Health. NIOSH operates a testing and certification program for respirators.
nitrile	A chemical-resistant synthetic material used to make gloves that are acceptable for handling pesticides.
non-residual	A substance which breaks down quickly and leaves no biologically active material behind.
non-selective	A herbicide which is effective on all plants it contacts.
non-systemic	A pesticide which stays on the surface of a plant. It does not enter it or move through all its parts.
noxious	Harmful.
ocular	Concerning the eyes.
oral	Taken into the body through the mouth.
organochlorine insecticides	Organic chemicals containing chlorine, e.g. endosulfan, dicofol.
organophosphorus insecticides	Synthetic organic insecticides which contain phosphorous, giving acute toxic effect due to inhibition of the enzyme cholinesterase.
orifice disc	Part of a combination spraying systems nozzle. The disc has a circular opening from 1/64 to 12/64 of an inch in diameter (D-1 to D-12).
particulate or bait	Mixture of large particles not recognized as a pellet or granular formulation. Mixed with edible inerts.
parts per million (ppm)	A measurement of a minute amount of pesticide residue usually in milligrams per kilograms.
pellet	Preformed mixture of a.i. and inerts to form spheres or cylinders.
perennial	A plant which lives for several years.
persistence (persistent)	The ability of some chemicals to remain in the environment without change for a long period of time.
pest	Undesirable organism.

Pest Control Products Act (PCP Act)	The Act administered by Agriculture Canada (PCP Act) requiring a pesticide to be adequately tested before registration and sale. The pesticide product must carry a PCP registration number before legal sale.
pesticide	Any device, organism, substance or mixture of substances intended for killing, controlling or managing pests, such as insects, rodents, fungi, weeds.
Pesticides Act	The Act regulating pesticides in Ontario. Under the Act, all pesticides registered for sale federally must be classified in Ontario into one of six schedules.
photo-allergic	Allergic response to pesticides, activated by sunlight.
physical control	Removing the pest from the crop by pruning, cultivation, etc.
piston pump	This pump is similar to a car's engine. Pistons draw the pesticide solution in through inlet valve on a down stroke, and force it out an outlet valve on the upstroke. It is a high capacity pressure pump that requires high power to operate.
poison	A chemical which, when taken in small quantities, causes illness or death.
Poison Information Centres	Located in all Provinces, Centres provide first aid information for poisoned victims, and antidotes and treatment procedures to doctors.
pollutant	Any form of contaminant that spoils the natural environment.
positive displacement pump	Any type of pump that works by building up pressure in the output line. They are also self-priming.
post-emergence	A herbicide treatment applied after the crop has emerged from the soil.
powered air purifiers	A helmet system respirator having a motor-blower which forces air through a filter.
precautions	Safety warnings found on the label of a pesticide product. Tells how to use the product safely (e.g. - protective clothing).
pre-emergence	A herbicide treatment applied before the crop has emerged from the soil.

pre-harvest interval	The least number of days between the last pesticide application and the harvest date, as indicated on the label.
premature	Any time in the growth of an organism before it is completely developed.
pre-plant treatment	A herbicide treatment applied before the crop is planted. It may be applied when the land is being prepared for planting or immediately before seeding time.
pressure regulating valve	A spring-loaded valve which absorbs pressure variations in the pressure line of a sprayer. It returns excess pressure-driven liquid back to the tank by a pressure relief line.
principal display panel	Front panel of a pesticide label.
protectant	A fungicide applied to healthy plants to kill fungus spores before they infect the plant.
pulsation damper	A small tank containing pressurized air which is attached to the pressurized line from a pump. It absorbs changes in pressure that result from changing output volumes during application.
pump housing	The enclosure that contains all the internal working parts of the pump.
P.V.C.	Polyvinylchloride - a form of vinyl used in manufacturing.
re-entry time	The length of time that must pass before a worker not wearing suitable protective clothing is permitted to enter an area to which a pesticide has been applied.
registered pesticide	A pesticide accepted under the Pest Control Products Act for the uses and purposes claimed. The PCP registration number must be displayed on the label of each pesticide container sold or used in Canada.
registrant	Person or company having registered a product.
repellents	Substances which pests avoid and will therefore keep the pests away from the target. They are used for mosquitoes and biting flies.
residual	A residual pesticide continues to work for a period of time after its application. Residual pesticides do not break down quickly in the soil but may last for weeks, months or years.

residue	The amount of pesticide that remains on a crop, animal or surface for a period of time after it has been treated.
residue tolerances	The maximum level of residues that may lawfully be on or in food.
respirator	A device designed to protect the wearer from breathing in hazardous air. There are three kinds: quarter-facepiece (covers above the chin), half-facepiece (under the chin), and full-facepiece (covers nose, mouth, and eyes). It is designed to make a tight fit with the face to keep out gas or particles.
rinsing device	Equipment which uses pressurized water to rinse containers as effectively as triple rinsing.
risk	The possibility of exposure and the amount of harm that may result.
rodenticide	A pesticide used to control or kill rodents.
roller pump	An inexpensive, positive displacement pump, with nylon, rubber or metal rollers contained in a housing. When the rollers revolve they move the liquid forcefully from the intake to the output valve.
Schedule	The Ontario Ministry of Environment and Energy places all registered pesticide products acceptable for use in Ontario into one of 6 schedules (or groups). The schedule depends on the toxicity, concentration, hazard to the applicator, hazard to the environment and other characteristics of the product.
sealant	A material which makes a surface moisture-resistant. For example, epoxy sealing paint for cement floors of a pesticide storage area.
secondary display panel	The back or side panel of a pesticide label.
sediment	Any solid substance which settles out of a solution and goes to the bottom of the container.
seed treatment	A liquid or powdered pesticide which is applied to the surface of the seed
selective	Any herbicide which will kill some plants but not others. For example, 2,4-D kills broadleaf plants but not grasses.
self-priming	A pump that is designed to draw liquid up into itself, without affecting its ability to perform.

sensitive crops	Crops which are easily injured by pesticide chemicals - even slight drift can cause problems.
sensitizer	A substance which causes little or no reaction on first exposure. With repeated exposures, however, it may cause a severe response not necessarily limited to the contact site. Skin sensitization is the most common form although respiratory sensitization is also possible.
siphon	The process of drawing a liquid "up-hill" from one container to another. The flow is started by suction and continues because of gravity and surface tension. For example - gasoline can be siphoned from a tank into a can with a length of hose.
smoke bombs	A form of pesticide which on burning releases aerosols, gases, and vapours to fumigate greenhouses and mushroom houses.
soil fumigant	A pesticide used to control pests in the soil. When added to the soil, it takes the form of a gas or vapour. Since it can evaporate quickly, it is often used with some kind of cover.
soil sterilants	Non-selective residual herbicides which are applied to soil to prevent growth of plants for a long period of time (a few months to many years).
soluble powder or granules	A dry material similar to dust or granules except it is soluble in water.
solvent	An organic liquid used to dissolve non water soluble substances.
Spills Action Centre	A centre established to receive calls reporting spills and to provide information concerning clean-up. Operated by the Ministry of the Environment and Energy - 1-800-268-6060.
spores	Tiny "seeds" which are produced by a fungus and spread in the air. When they germinate, some spores can cause infection on certain plants.
sticky pastes	Substances used to trap insects. They may contain specific colours or attractants.
suction	The process of drawing liquid from a spray tank by the vacuum force exerted by a pump.
summer annual	A plant which completes its life cycle in one year, germinating in the spring and dying in the fall or winter of the same year.

supplied-air respirator	These respirators supply air through a tube to the headpiece from a tank on the wearer's back (Self Contained Breathing Apparatus).
surfactant	A substance which reduces the surface tension of a liquid to make it spread out over a surface, rather than "bead-up" in small droplets.
surge tank	Relieves sudden changes in line pressure and prevents damage to the pump. Similar to a pulsation damper.
suspension or flowable	A cloudy liquid composed of solid particles of a.i. (finely ground) in a liquid. Needs dilution.
symptom	An outward sign of a disease or poisoning.
synapse	A gap between one nerve fibre and another.
synergism	The increased effectiveness achieved when two chemicals are used together, compared to their effectiveness when used alone.
syrup of ipecac	A liquid used to induce vomiting for certain cases of pesticide poisoning.
systemic	A pesticide which is absorbed into a living organism and moves through it into all parts.
tablet	A measured amount of a mixture of active ingredient and inert material pressed into a convenient shape.
target	Where the pesticide is to be applied - for example, the soil surface or the leaf of a plant.
technical material	The pesticide (active ingredient) as it is manufactured by a chemical company before formulation.
test animals	Laboratory animals exposed to pesticides to measure toxicological effects - rats, mice, rabbits, birds or fish.
throttling valves	Controls on the pressure line from a pump which increase or reduce the flow by restricting the size of the opening in the line.
tiller	A secondary shoot on a grass plant.
toxicity	The ability of a substance to cause human injury, sickness or other unwanted effects.
trade name	A name given to a product by the manufacturer to identify it.

Transportation of Dangerous Goods Act	A federal Act, administered by Transport Canada, promoting public safety in the transportation of dangerous goods. Many pesticides are classed as dangerous goods.
trigger pump sprayers	A kind of sprayer which forces pesticide mixture through a nozzle when the trigger is squeezed.
triple rinse	Method of properly rinsing containers by filling the container 10% full with diluent, then capping, shaking the container and adding the rinsate to the spray tank. Repeated two more times.
true leaves	The leaves which appear after the cotyledons and remain intact throughout the life of the plant.
true liquid/solution	When the active ingredient is mixed with water, the water remains clear.
turbulence	Rapid movement of a liquid that causes mixing.
Ultra Low Volume (ULV)	Used to apply pesticide that is almost pure formulated product. Application rates are only 5 to 6 L/ha or less.
vacuum	Any air pressure that is less than the air surrounding it.
vaporize	When certain pesticides are applied to a crop and subjected to heat from sunlight, they may break down to produce gases that are lighter than air. These vapours can drift with air currents to other areas where they may cause damage.
volatility	Refers to the ease with which a material evaporates.
volatilization	This is the process of vaporization by a pesticide.
wettable powder	a.i. added to powder (clay, talc) containing a wetting and dispersing agent. Forms a suspension in water.
wetting agent	An adjuvant added to pesticides to promote spreading.
wick applicator	A specialized applicator for pesticides which is made of an absorbent material like cloth. The cloth is saturated with pesticide then wiped over the weed surface
winter annual	A plant which completes its life cycle in one year, germinating in the fall, flowering and dying in the spring/summer of the following year.
working pressure	The range of pressure at which a pump is rated to operate. The highest safe working pressure is usually 80% of the maximum pressure.

Answers to Review Questions

How Pesticides are Regulated

1. Pest Control Products/Federal
2. TRUE
3. TRUE
4. Food and Drugs
5. Environmental Contaminants
6. The Pesticides Act and Regulation
7. Home owner - 3, 4 and 6
Agriculturist - 1, 2, 3, 4, 5, 6
8. e

Enforcement of the Pesticides Act

1. a) \$10,000/day
b) \$50,000/day

Classification of Pesticides

1. Any of the following:
 1. toxicity
 2. environmental hazard
 3. health hazard
 4. persistence
 5. concentration
 6. use

1. certified: the farmer has passed the Grower Pesticide Safety Course within the last 5 years.
agriculturist: the farmer uses farm land for agricultural or forestry production, farming at least 5 ha or averaging an annual gross revenue (over 3 years) \geq \$4,000.
2. an outlet representative must have passed the Pesticide Vendor Certification Course in the past 5 years and must also work full time at the outlet.
3. Schedule 3 products must be displayed at least one metre above ground level so that they present minimal hazard to children.
4. a) Retail Class 1
b) no vending licence required
5. a) permit holder
b) homeowner (anyone)

1. TRUE
2. 1. domestic
2. commercial
3. restricted
4. manufacturing
3. d
4. toxicological
5. A **Danger**
Flammable
B **Warning**
Corrosive
C **Caution**
Explosive
D **Warning**
Poison
E **Caution**
Flammable
6. 1. before buying
2. before using
3. before disposing or storing
7. DANGER
8. Corrosive
Poison
Explosive

Pesticide Formulations

1. FALSE
2. TRUE
3.
 1. liquids
 2. solids
 3. gases
4. $EC = c$
 $WP = e$
 $F = b$
 $G = f$
 $Sc = a$
 $SP = d$
5. A high concentration of a.i. supplied per container.
6. Highly toxic. Area to be fumigated must be well sealed.
7. e
8. FALSE
9. TRUE

The Material Safety Data Sheet (MSDS)

1. If you need more detailed information than is available on the label.
2. Any 1 of the following:
 1. Manufacturer of the pesticide
 2. Supplier

Risk of Pesticide Use

1. FALSE
2. d
3. b
4. c
5.
 1. dermal absorption
 2. oral absorption
 3. inhalation absorption
6. acute
chronic
7. Possible answers may include:
 1. Do not store pesticides in empty containers previously used for food stuff.
(i.e. liquor, soft drink bottles)
 2. Wash your hands after using pesticides to prevent contamination.
 3. Wear gloves.
 4. Do not use the mouth to siphon pesticide liquids or clean nozzles.
 5. Do not eat, drink or smoke when handling pesticides.
 6. Do not leave open containers unattended.
 7. Triple rinse empty containers, puncture and dispose of them so that they may not be re-used.
8. Possible answers may include:
 1. Wear gloves.
 2. Wear long sleeved shirt and pants or coveralls.
 3. Wash off any pesticide that spills onto your skin or clothes immediately.
 4. Avoid cloth hats and leather boots since they absorb pesticides.
 5. Wear waterproof hat and boots.
 6. Wear goggles to avoid splashes to the eyes.
 7. Spray so that the wind carries pesticides away from you.
 8. Wash clothing used for pesticide application separately.
9. Possible answers may include:
 1. Wear a respirator.
 2. Avoid dusts when working with dry/granular pesticides.
 3. Do not spray when wind conditions are not favourable.
 4. Keep storage area well ventilated.
 5. Avoid re-entry into a field without proper protective clothing and before the suggested time period has elapsed.
 6. Do not smoke during application and do not use contaminated smoking supplies.
 7. Use low volatility formulations.

Pesticide Poisonings

1. d
2. TRUE
3. Small spray droplets present a greater inhalation hazard than larger droplets since they are easier to inhale.
4. e
5. TRUE
6. chronic
acute
7.
 1. Organochlorine insecticides
 2. Organophosphorus insecticides
 3. Carbamates
8. TRUE
9. TRUE
10. Cholinesterase Blood
 1. before exposure or the spray season begins
 2. during the spray season
 3. after exposure or after the spray season ends

First Aid

1. Find and wear the proper protective clothing and equipment before entering the contaminated area.
2.
 1. Hold eyelids open and wash with large amounts of clean running water.
 2. Wash for 15 minutes or more.
 3. Get medical attention.
3. d
4. FALSE

First Aid Cont.

5.
 1. Wear protective equipment.
 2. Carry the victim to fresh air.
 3. Loosen tight clothing.
 4. Give artificial respiration if necessary.
 5. Get medical attention.
6. FALSE

Protective Clothing & Equipment

1. e
2. Water repellent clothing, goggles, gloves, boots.
3. During the mixing and loading operation, the pesticide is in a concentrated form and has not yet been diluted.
4. FALSE
5. Wear pant legs outside the boots to avoid getting pesticides inside the boot.
6. Change the cartridges whenever you can smell or taste pesticides, or at least after one year of use.
7. c
8. Avoid wearing baseball type hats or hats with cloth or leather sweat bands.
9. For maximum protection, fold down the top of the glove to make a cuff and tuck glove under sleeve.
10. The precaution section.
11. TRUE
12. d

Transportation of Pesticides

1. TRUE
2. e
3. TRUE
4. No, providing the pesticide is not a poisonous or corrosive gas, or a substance that produces a flammable gas when mixed with water.
5. If the pesticide is a regulated pesticide under the Transportation of Dangerous Goods Act (TDGA), then the holding tank must have a placard since the quantity is less than 5,000 L. Also, the holding tank must have a Ministry of Environment and Energy Chemical Storage Warning Sign since it is holding more than 500 L.
6.
 1. shipper
 2. destination
 3. type of product
 4. product classification
 5. degree of hazard
 6. emergency telephone numbers
7. e
8. Wear proper protective clothing and equipment and clean and decontaminate the vehicle.
9. The Spills Action Centre.

How to Dispose of Pesticides Safely

1. TRUE
2.
 1. Fill container at least 10% full of diluent.
 2. Cap and shake container.
 3. Empty rinsings into spray tank.
 4. Repeat steps 1 to 3 two more times.
3. FALSE
4. Pesticides Act and Regulation
5. FALSE

How to Dispose of Pesticides Safely Cont'd

6. TRUE
7. Any two of the following:
 1. Properly identify the pest and chose the right pesticide.
 2. Know the size of the treated area.
 3. Calibrate your sprayer to know the output.
 4. Check the quantity required before mixing the solution.
8. FALSE
9. TRUE
10.
 1. If in original container, return to supplier.
 2. Use on farm for labelled use.
 3. Contact the Pesticides Officer at the local MOEE office.
 4. Take to a municipale "Waste Day".

How to Store Pesticides Safely

1. A Wholesale or Limited Wholesale Vendor
2.
 1. leave the vehicle "unaccessible" to the public
 2. lock the pesticides in a compartment (not the passenger area)
 3. post a "Chemical Storage Warning" sign on the vehicle
3.
 1. trade name or common name
 2. concentration of each a.i.
4.
 1. no contact with food or drink
 2. not impair health or safety
 3. clean and orderly manner
 4. warning sign posted
 5. emergency numbers posted

Pesticides and the Environment

1.
 1. accumulation
 2. persistence
 3. volatilization
 4. absorption
 5. degradation
2. accumulation
3. persistent
4. Persistent pesticides remain stable, allowing them the opportunity to move from their target site of application. They can also carry over to the next year causing injury to the next year's crops.
5.
 1. surface runoff
 2. leaching
 3. drift
6.
 1. atrazine
 2. simazine
 3. metolachlor
7. FALSE
8. beneficial
9. Possible answers may include:
 1. Keep records of the type and amount of pesticides applied.
 2. Plan programs to avoid frequent use of a group of pesticides.
 3. Use alternate sprays of different chemical families.
 4. Apply the recommended rate.
 5. Correctly calibrate the sprayer.
 6. Plan crop rotations.
 7. Use pesticides only when necessary.

Food Safety

1. Health Canada; Agriculture and Agri-Food Canada; OMAFRA.
2.
 1. reduce pesticide use
 2. use IPM
 3. follow label directions
 4. use the most current agricultural practices

Choosing the Right Pest Control

1. TRUE
2. Economic Injury Level is when the amount of damage caused by the pest is equal to the cost of controlling the pest.
3.
 1. Physical control (cultivating)
 2. Cultural control (crop rotation)
 3. Biological control (parasites to control whitefly in greenhouses)
 4. Genetic control (disease resistant varieties)
4. TRUE
5. Any 2 of the following:
 1. Use different types of pest control. (i.e. - physical, cultural)
 2. Use pesticides only when necessary.
 3. Use pesticides from different chemical families.

Weeds and Their Control

1.
 - physical = d
 - biological = c
 - cultural = b
 - chemical = a
2. Control of perennial weeds is most effective when they are flowering
3. TRUE
4. Weeds that complete their life cycle within one year.

Insects and Their Control

1. TRUE
2. b
3. TRUE
4. d

Diseases and Their Control

1. TRUE
2. FALSE
3. TRUE

Animals and Their Control

1. TRUE
2. Any 2 of the following:
 1. removing the pests from a feeding or breeding location
 2. destroying their habitat
 3. encouraging nocturnal predators

Selecting and Purchasing Advice to Customers

1. This pesticide recommendation was taken from OMAFRA Publication 363. Fill in the chart.

European Corn Borer - Sweet Corn			
	Re-entry Period	Interval to Harvest	Ontario Schedule
AMBUSH (permethrin)	0	1 day	3
RIPCORDER (cypermethrin)	0	5 days	2
FURADAN (carbofuran)	48 hours	7 days	5,2
LANNATE (methomyl)	24 hours	3 days	5,2

2. This pesticide recommendation was taken from OMAFRA Publication 360. Fill in the chart.

Plum Curculio - Apple			
	Re-entry Period	Interval To Harvest	Ontario Schedule
GUTHION (azinphos-methyl)	48 hours	7 days	2,5
IMIDAN (phosmet)	0	1 day	3
ZOLONE (phosalone)	0	1 day	2
BELMARK (fenvalerate)	0	60 days	2

3. List two brand names, formulation types and concentrations under which metribuzin (a herbicide) is sold - Publication 75.

Brand Name	Formulation Type	Concentration of a.i.
LEXONE DF	dry flowable	75 %
SENCOR 500 F	Su	500 g/L

Selecting and Purchasing Advice to Customers Cont'd

4. Any 2 of the following:
1. FURADAN (carbofuran)
 2. APM, GUTHION (azinphos-methyl)
 3. MONITOR (methamidophos)
 4. METASYSTOX-R (oxydemeton-methyl)

5. What is the Ontario Schedule of:

Pesticide	Ontario Schedule #
BRAVO (chlorthalonil)	3
captan	2
parathion	5

6. a) 1. carbaryl
2. chlorpyrifos
3. diazinon
- b) For example carbaryl:
Co-op Liquid Sevin
Green Cross Liquid Sevin
Green Cross 50% Spray
Sanex Liquid Sevin
Willson Liquid Sevin

Application Equipment

1. Hose end sprayers = a
Compressed air sprayers = d
Low-pressure boom sprayers = e
Air-blast sprayers = c
Ultra-low volume sprayers = b

Application Equipment Cont'd

2. FALSE
3. c
4. pressure gauge
5. d
6.
 1. tank filler opening (tank screens)
 2. suction line (suction line filters)
 3. pressure line (pressure line filters)
7. TRUE
8. Remove nozzles and screens. Clean thoroughly in a kerosene or detergent solution using a soft brush. Store in light oil.
9. TRUE
10. FALSE
11. Fumigants are highly toxic gases.

Calibration of Application Equipment

1. Fill the spray tank to a mark with water. Pump to the pressure which will be used during the pesticide application.

Apply the spray of water to 100 m². Walk at a steady pace, applying as evenly as possible.

Measure the amount of water needed to refill the spray tank to the mark. This volume will be the sprayer's output per 100 m².

2. Delevan LF-2 at 275 kPa or Teejet nozzles 6502 and 8002 at 275 kPa.
3. e

How Well Pesticides Work

1. Any 3 of the following:
 1. wind
 2. temperature
 3. humidity
 4. volatility
 5. droplet size
 6. nozzle to target distance
 7. adjuvants
2. TRUE

Applying the Right Amount of Pesticide

1. e
2. a) $10 \text{ ha} \times 2 \text{ applications} = 20 \text{ ha}$
 $20 \text{ ha} \times 2 \text{ L/ha} = 40 \text{ L SEVIN XLR}$

b) $\frac{1000 \text{ L}}{250 \text{ L/ha}} = 4 \text{ ha}$

c) $4 \text{ ha} \times 2 \text{ L/ha} = 8 \text{ L in each tank}$
3. a) $2 \text{ L/ha rate} \times 0.4 \text{ conversion} = 0.8 \text{ L/acre rate}$
 $0.8 \text{ L/acre rate} \times 45 \text{ acres} = 36 \text{ L of BRAVO}$

b) $\frac{500 \text{ gallons}}{50 \text{ gallons/acre}} = 10 \text{ acres for each tank}$

c) $0.8 \text{ L/acre rate} \times 10 \text{ acres/tank} = 8 \text{ L BRAVO/tank}$

Keeping Pesticide Records

1. Any 3 of the following:
 1. evaluate your results
 2. improve pest control practices
 3. avoid pesticide misuse
 4. inventory control
 5. document procedures
 6. solve problems

Health and Safety on the Job

1. 1. Material Safety Data Sheets
2. Pesticide Label
3. Technical Data Sheets
4. Supervisor/Supplier

Pesticide Spills

1. Wearing protective clothing and equipment.

Pesticide Fires

1. Notify the fire department that pesticides are stored in the warehouse.
2. Fire prevention:
 1. do not use open flames for welding, burning, cutting, etc.
 2. keep a fire extinguisher close by
 3. use stretch wrapping rather than shrink wrapping
 4. make sure pesticide storage construction, electrical installations and equipment are up to date
 5. keep unauthorized people from entering

Emergency Planning

1. 1. protect yourself
 2. protect others
 3. administer first aid
 4. secure the site
 5. call emergency authorities and helpers
2. Review your plan with local authorities (fire, police dept.), provincial authorities, municipal authorities, emergency helpers from the community, employees, lawyer and insurance agent.

Be a Professional

1. You can develop and maintain good public relations by:
 1. knowing your business
 2. having a professional attitude and image
 3. demonstrating good work habits
 4. communicating with your community
 5. communicating with your customers
 6. knowing the products you sell

Information Numbers

(not for an emergency)

PROVINCIAL

Provincial Pesticide Regulatory Office (416) 323-5095

Standards Development Branch, Pesticides Section
Ontario Ministry of Environment and Energy
2 St. Clair Avenue West, 12th Floor
TORONTO, Ontario
M4V 1L5

Mailing Address:

135 St. Clair Avenue W., Suite 100, Toronto, M4V 1P5

Pesticide Licencing and Examination Section (416) 440-3713

Approvals Branch
250 Davisville Avenue, 3rd Floor
TORONTO, Ontario
M4S 1H2

Transportation of Dangerous Goods

Contact Regional Ministry of Transportation Office

Ontario Pesticide Education Program (519) 674-1580

Ridgetown College of Agricultural Technology
Main Street East
RIDGETOWN, Ontario
N0P 2C0

FEDERAL

**Accidents, Spills (Environment Canada)
(416) 973-1059**

Regional Environmental Emergency Offices
Regional Environmental Emergency Co-ordinator
Environment Canada
7th Floor, Arthur Meighen Blvd.
25 St. Clair Avenue East
TORONTO, Ontario
M4T 1M2

**Agriculture and Agri-Food Canada
Pesticide Information Line
1-800-267-6315**

Operates Monday to Thursday - 10:00 a.m. to 3:00 p.m.

Information is available on pesticides such as

- update of registered uses
- registered tank mixes
- public concern issues

Ontario Ministry of Environment and Energy

Pesticides Control Field Offices

Head Office Standards Development Branch, Pesticides Section (416) 323-5095
135 St. Clair Ave. W.
Suite 100
Toronto, M4V 1P5

Region	Counties	Field Offices	Telephone
Central	Halton, Peel, York, Durham, Toronto, Simcoe, Muskoka	7 Overlea Blvd. Don Mills M4H 1A8	(416) 424-3000
West-Central	Haldimand-Norfolk, Niagara, Dufferin, Hamilton-Wentworth, Wellington, Waterloo, Brant	Ontario Gov't. Bldg. 119 King Street W. Hamilton L8N 3Z9	(905) 521-7640
Southwestern	Elgin, Middlesex, Oxford	985 Adelaide St. S. London N6E 1V3	(519) 661-2255
	Essex, Kent, Lambton	P.O. Box 726 435 Grand Ave. W. Chatham N7M 5L1	(519) 354-9434
	Bruce, Grey, Huron, Perth	120 King Street P.O. Box 159 OMAFRA Bldg. Clinton N0M 1L0	(519) 482-3428

Region	Counties	Field Offices	Telephone
Eastern	Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/ Dundas & Glengarry	P.O. Box 820 133 Dalton Street Kingston K7L 4X6	(613) 549-4000
	Peterborough, Victoria, Northumberland	1477 Landsdowne St W. Peterborough K9J 3G6	(705) 743-2972
	Renfrew, Ottawa- Carleton, Lanark, District of Nipissing (Townships of Airy, Murchison, Dickens, Lyell and Sabine)	2435 Holly Lane Suite 204 Ottawa K2V 7P2	(613) 521-3450
Mid-Ontario	Manitoulin, Nipissing, Parry Sound, Sudbury, Cochrane, Algoma Timiskaming	199 Larch Street Sudbury P3E 5P9	(705) 670-3247
Northern	Kenora, Rainy River, Thunder Bay	Ontario Gov't. Bldg. 435 James Street S. Thunder Bay P7B 5G6	(807) 475-1712

Safety Supply Companies in Ontario Providing Protective Clothing & Equipment

Company		Address	Telephone & Fax Numbers
3-M Canada Inc.	Head Office	Occupational Health and Environmental Safety Box 5757 London, On. N6A 4T1	(519) 451-2500
Cabot Safety Canada Ltd.	Head Office	7115 Tomken Rd. Mississauga, On L5S 1R8	(905) 795-0700 Fax: (905) 564-5250
Dutch Industries (manufacturers of "Protect-Air Cab Filter")	Head Office	705 First Avenue Regina, Sask. S4N 4M4	(306) 949-9522
	Offices in Ontario	Huron Tractor Box 1300 Exeter N0M 1S0	
Kappler Canada	Head Office	Box 1687 21 Ryan Place Brantford, On N3T 5V7	(519) 752-4369
Levitt-Safety (Eastern) Limited	Head Office	2872 Bristol Circle Oakville, On L6H 5T5	(905) 829-3299
	Offices in Ontario	2872 Bristol Circle Oakville L6H 5T5	
		210 Colonnade Rd, Unit 6 Nepean K2E 7L5	
		2140 Regent St. S, Unit 6 Sudbury P3E 5S8	
		741 Harold Crescent Thunder Bay P7C 5H8	
		764 Confederation St. Sarnia N7T 2E3	

Company		Address	Telephone & Fax Numbers
MSA Canada Inc.	Head Office	48 Norfinch Drive North York, On M3N 1X8	(416) 667-9400
Mitt & Robe Co.	Head Office	751 Norfolk St. N. Simcoe, On N3Y 3R6	(519) 428-4050 Fax (519) 428-5142
Plant Products Co. Ltd.	Head Office	314 Orenda Road Brampton, On L6T 1G1	(905) 793-7000
Safety House Inc.	Head Office	232 Millway Ave. Concord, On L4K 3W6	(905) 660-5800 Fax (905) 660-5042
Safety Supply Canada	Head Office	90 W. Beaver Creek Rd Richmond Hill, On L4B 1E7	(905) 222-4111 (905) 222-2111 Fax (905) 731-9677
	Offices in Ontario	3370 South Service Rd. Burlington L7N 3J5	(416) 634-4439 Fax (416) 634-8466
		567 Memorial Ave. Thunder Bay P7B 3Z1	(807) 345-2207 Fax (807) 354-9751
		797 Lorne St. S. Sudbury PWC 4R5	(705) 674-7738 Fax (705) 671-2829
		581 Vidal St. S. Sarnia N7T 2V8	(519) 336-9322 Fax (519) 336-6805
		Toronto Retail Store: 214 Ling Street E. Toronto M5A 1J8	(416) 364-4833
		Scarborough Retail Store: 947 Warden Avenue Scarborough M1L 4E3	(416) 751-6110
		1060 Belfast Road Ottawa K1B 3S3	(613) 745-0055 Fax (613) 745-9317

Company		Address	Telephone & Fax Numbers
The Saint George Company (Suppliers of Kasco Helmets)	Head Office	206 McPherson School Rd St. George, On N0E 1N0	(519) 442-2046 Fax (519) 442-7191
	Offices in Ontario	Gibson Agricultural Supp. Bowmanville L1C 3K8	(905) 623-3358
		J.B. Puddicombe & Sons Ltd Winona	(905) 643-1392
		Cargill Fertilizers Ltd Waterford	(519) 443-8684
		O.A. Goertz Equip. Ltd Niagara-on-the-Lake L0S 1J0	(905) 934-9869
		Agrospray Chemicals Ltd Tillsonburg	(519) 842-8408
		Harrow Farmers' Co-operative Assoc. Ltd., Harrow	(519) 738-2224
		Harrow Feed Store Ltd., Harrow	(519) 738-2261
		Kent Farm Supplies Ltd Blenheim N0P 1A0	(519) 676-5429
		Millgrove Warehouse Ltd Millgrove L0R 1V0	(905) 689-5400
		Morse Growers Supplies (1979) Ltd Leamington, N8H 3W1	(519) 326-9037
		Profoto's Farm Equip. Ltd Chatham	(519) 354-5100

The Metric System

Area

$$\begin{array}{rcl} 100 \text{ m} \times 100 \text{ m} & = & 10,000 \text{ m}^2 = 1 \text{ hectare (ha)} \\ 100 \text{ ha} & = & 1 \text{ square kilometre (km}^2\text{)} \end{array}$$

Measures

$$\begin{array}{rcl} 1,000 \text{ millilitres (mL)} & = & 1 \text{ litre (L)} \\ 1,000 \text{ milligrams (mg)} & = & 1 \text{ gram (g)} \\ 1,000 \text{ g} & = & 1 \text{ kilogram (kg)} \end{array}$$

Weight - Volume Equivalents (for water)

$$\begin{array}{rcl} (1.00 \text{ kg}) 1,000 \text{ grams} & = & 1 \text{ litre (1.00 L)} \\ (0.001 \text{ kg}) 1 \text{ g} & = & 1 \text{ mL (0.001 L)} \end{array}$$

Application Rate Conversion (approximate)

Metric to Imperial (approximate)

litres per hectare	x	0.09	=	gallons per acre
litres per hectare	x	0.36	=	quarts per acre
litres per hectare	x	0.71	=	pints per acre
millilitres per hectare	x	0.015	=	fluid ounces per acre
grams per hectare	x	0.015	=	ounces per acre
kilograms per hectare	x	0.89	=	pounds per acre
tonnes per hectare	x	0.45	=	tons per acre

Imperial to Metric (approximate)

gallons per acre	x	11.23	=	litres per hectare (L/ha)
quarts per acre	x	2.8	=	litres per hectare (L/ha)
pints per acre	x	1.4	=	litres per hectare (L/ha)
fluid ounces per acre	x	70.0	=	millilitres per hectare (mL/ha)
tons per acre	x	2.24	=	tonnes per hectare (t/ha)
pounds per acre	x	1.12	=	kilograms per hectare (kg/ha)
ounces per acre	x	70.0	=	grams per hectare (g/ha)

U.S. to Metric (approximate)

gallons per acre	x	9.35	=	litres per hectare (L/ha)
------------------	---	------	---	---------------------------

Metric to U.S. (approximate)

litres per hectare (L/ha)	x	0.11	=	U.S. gallons per acres
---------------------------	---	------	---	------------------------

Conversion Table

	Metric to Imperial	Imperial to Metric
Area	1 hectare (ha) = 2.5 acres	1 acre = 0.4 ha
Pressure	1 kilopascal (kPa) = 0.15 psi	1 psi = 6.9 kPa
Volume (liquid)	1 litre (L) = 0.22 gallon (Imperial)	1 gallon (Imperial) = 4.55 L
	1 litre (L) = 0.26 gallon (U.S.)	1 gallon (U.S.) = 3.79 L
Weight	1 kilogram (kg) = 2.21 pounds	1 pound = 0.454 kg

Company	Address	Telephone & Fax Numbers
The Saint George Company (Suppliers of Kasco Helmets), Cont.	Offices in Ontario, Cont.	Norfolk Fruit Growers' Ass. Simcoe
		(519) 426-0640
		Phillips Farm Supply Brighton
		(613) 475-2040
		Smithyes Holdings Ltd., King City L0G 1K0
		(905) 833-6698
		Tarbert Farms Ltd. Dutton, N0L 1J0
		(519) 762-2113
Van Waters & Rogers Ltd	Head Office	Hargrieve Road
		London, On N6E 1P5
		(519) 668-3007
		(519) 442-2046
		1-800-265-7671

References

The following publications were used in the preparation of this manual and are recommended for further reading.

Alberta Environment. Pesticide Fire & Spill Guidelines. Pollution Control Division, Pesticide Chemicals Branch. 1984.

Beggs, G.L. Investigating Fish Kills: A Guide to Field Procedures. Ontario Ministry of the Environment. 1979.

Bohmont, Bert L. The New Pesticide User's Guide. Reston Publishing Co. Inc., Reston, Virginia. 1983.

Brady, Nyle C. The Nature and Properties of Soils. 9th Edition. New York: MacMillan Publishing Company. 1984.

British Columbia, Ministry of Environment and Parks. Handbook for Pesticide Applicators and Pesticide Dispensers. Fifth Edition, Province of British Columbia, Pesticide Control Branch. 1987.

Canada Agriculture. Pest Control Products Act 1982 and Regulations and Registration Guidelines. Pesticides Division, Ottawa, Ontario. January 1984.

Canada, Agriculture. Pesticide Safety. Research Branch Technical Bulletin 1987-10E. A.J. Cessna, Regina, Sa. 1987.

Canada, Health & Welfare. Basic Knowledge Requirement for Pesticide Education in Canada : Applicator Core. November, 1992.

Canada, Health & Welfare. Pesticide Handling, A Safety Handbook. 1986.

Canada, Health & Welfare. Poisoning Statistics. Product Related Accident Section, Product Related Disease Division, Health Protection Branch. 1985.

C.P.I.C. Task Force on Crop Protection Chemicals in Water. Water in Trust: Growers Guide. 1988.

- Crop Protection Institute. Warehousing Standard, Compliance Assistance Manual. 1990, 1992.
- Edwards, C.A. Persistent Pesticides in the Environment. 2nd Edition. Ohio: CRC Press. 1973.
- Farm Safety Association Fact Sheet. Selecting the Correct Respirator. 1985.
- Frank R. A Canadian Guide on Personal Protection for Farmers and Farm Workers Involved in Handling and Applying Pesticides and Working in Treated Areas. Prepared for the Canadian Association of Pest Control Officials by a Sub-committee on Personal Protection. 1987.
- Frank, R. Guide to Handling and Applying Herbicide to Protect Water Supplies and Reduce Personal Exposure. Ontario Ministry of Agriculture and Food, AGDEX 607. May 1987.
- Frank, R. Pesticide Contamination of Farm Water Supplies: Recommendations on Avoidance and Clean Up. Ontario Ministry of Agriculture and Food, AGDEX 607. October, 1986.
- Frank, R. Rural Water Quality and Pesticides. In Highlights of Agricultural Research in Ontario. Vol. 9, No. 4. December 1986.
- Frank, Richard and Brian D. Ripley. Management of Pesticides on the Farm. Ontario Ministry of Agriculture and Food, AGDEX 607. April, 1988.
- Government of Ontario. Environmental Protection Act and Regulation 308. 1986.
- Government of Ontario. Occupational Health & Safety Act and Regulations for Industrial Establishments. 1980.
- Government of Ontario. Pesticides Act 1990 and Regulation 914. 1992.
- New York State Co-op Extension Services. Pesticide Applicator Training Manual. Chemical & Pesticide Program. Cornell University, New York. 1984.
- Ontario Ministry of Agriculture and Food. Guide to Weed Control. Publication 75.
- Ontario Ministry of Agriculture and Food: Publications 162, Turfgrass diseases and Insect Pests; 360, Fruit Production Recommendations; 363, Vegetable Production Recommendations; 365, Pesticide Recommendations for Greenhouse Crops; 383, Production Recommendations for Nursery & Landscape Plants; 384, Recommendations for Turf Grass Management.
- Ontario Ministry of Agriculture and Food. Ontario Weeds. Publication 505. Alex, J.F. 1992.

Ontario Ministry of the Environment. Aluminum Phosphide Structural Fumigation. Agriculture & Industrial Chemicals Section. Hazardous Contaminants Co-ordination Branch. 1988.

Ontario Ministry of the Environment. Factsheets: Numbers 10-09-02; 20-03-01; 30-01-01; 30-01-03; 30-01-04; 40-01-02; 40-01-04; 80-04-01; 80-04-02; 80-04-03; 80-05-01.

Ontario Ministry of the Environment, Natural Resources and Labour. Guide to Eating Ontario Sport Fish. 1988.

Ontario Ministry of the Environment. Pesticides Safety Handbook. Agricultural & Industrial Chemicals Section, Hazardous Contaminants Co-ordination Branch. 1986.

Ontario Ministry of Labour, Occupational Health & Safety Division. A Guide to the Occupational Health & Safety Act. Occupational Health & Safety Division.

Smith, Robert Leo. Ecology & Field Biology. 2nd Edition. New York: Harper & Row Publishers. 1974.

Wilson, Curtis M., Broersma, Delmar B., & Provonsha, Arwin V. Practical Insect Pest Management. Waveland Press Inc., Illinois. 1977.

Personal Consultations with:

Doug Morrow, Regional Pesticide Officer, London, Ontario Ministry of the Environment
Dr. Michael McGuigan, Medical Director, Poison Information Centre
Dr. Richard Frank.

Notes

Notes



Notes

Notes



Notes

Notes

Notes

Notes

Emergency Numbers

Hospital _____

District MOEE _____

Police _____

Fire _____

Poison Information Centres

Available 24 hours, 7 days a week

Toronto

Hospital for Sick Children
555 University Avenue
M5G 1X8

Dr. M. McGuigan
Director

(416) 813-5900
1-800-268-9017

Ottawa

Children's Hospital of Eastern Ontario
401 Smyth Road
K1H 8L1

Dr. R. Peterson
Director

(613) 737-1100
1-800-267-1373

Spills Action Centre

(Ministry of Environment and Energy)

1-800-268-6060

Call Regional Offices during office hours

Dangerous Goods Emergencies

CANUTEC

Canadian Transport Emergency Centre
Transport Canada

(613) 996-6666

Emergency Numbers

Hospital _____

District MOEE _____

Police _____

Fire _____

Poison Information Centres

Available 24 hours, 7 days a week

Toronto

Hospital for Sick Children
555 University Avenue
M5G 1X8

Dr. M. McGuigan
Director

(416) 813-5900
1-800-268-9017

Ottawa

Children's Hospital of Eastern Ontario
401 Smyth Road
K1H 8L1

Dr. R. Peterson
Director

(613) 737-1100
1-800-267-1373

Spills Action Centre

(Ministry of Environment and Energy)

1-800-268-6060

Call Regional Offices during office hours

Dangerous Goods Emergencies

CANUTEC

Canadian Transport Emergency Centre
Transport Canada

(613) 996-6666

LEGISLATIVE LIBRARY OF ONTARIO



9693600020309